RS 02 – Hydrogeological – Drill Hole Monitoring and Data Collection – Phase 1

Hydrogeologic Investigation – Phase 1
PolyMet NorthMet Mine Site
RS-02

Table of Contents

Executive Summary iii

1.0 Introduction 1
1.1 Background 1
1.2 Scope of Work 2
1.3 Report Organization 2

2.0 Characterization of Surficial Sediment 3
2.1 Field Activities and Data Collection Methodology 3
2.1.1 Soil Boring Advancement 3
2.1.2 Geotechnical Sampling 3
2.1.2 Well Installation 4
2.1.3 Aquifer Performance Testing 5
2.1.4 Groundwater Sampling 5
2.2 Field Investigation Observations and Results 6
2.2.1 Geology 6
2.2.2 Geotechnical Testing 6
2.2.3 Aquifer Performance Testing 6
2.3 Analytical Results 7

3.0 Characterization of the Duluth Complex 8
3.1 Field Activities and Data Collection Methodology 8
3.1.1 Aquifer Performance Testing 8
3.1.2 Groundwater Sampling 9
3.2 Field Investigation Observations and Results 9
Aquifer Performance Testing 9
3.3 Analytical Results 10

4.0 Quality Assurance 11

5.0 Summary and Conclusions 13
5.1 Surficial Aquifer 13
5.2 Duluth Complex 13
5.3 Conclusions 14

References 15

List of Tables

Table 1 Groundwater Analytical Parameter with Analysis Method

Table 2 Surficial Aquifer Test Data

Table 3 Geotechnical Test Results, Classification, Water Content, Atterberg Limits, Specific Gravity, and Organic Matter

Table 4 Geotechnical Test Results, Proctor and Permeability

Table 5 Surficial Aquifer Analytical Data

Table 6 Duluth Complex Aquifer Test Data

Table 7 Bedrock Aquifers Analytical Data

List of Figures

Figure 1 Site Location Map

Figure 2 Site Layout with March 2005 Hydrogeologic Investigation Locations

List of Appendices

Appendix A Rotasonic Boring and Well Construction Logs

Appendix B Aquifer Performance Test Analyses

Appendix C Field Sampling Data Sheets

Appendix D Groundwater Analytical Data Reports

Appendix E Geotechnical Sample Analysis

Supplemental Electronic Data

Aquifer Test Groundwater Elevation Data

Executive Summary

An initial hydrogeologic investigation was conducted at the PolyMet mine site (the Site). The objective of this investigation was to determine the hydraulic properties and water quality from the Duluth Complex and the surficial deposits at the Site. In addition, preliminary geotechnical information was collected on the surficial deposits.

Ten shallow borings were advanced through the surficial sediment at the Site, terminating in bedrock, in order to visually inspect the sediment encountered and to perform aquifer performance tests. Three of the surficial aquifer borings were converted to monitoring wells, from which groundwater samples were collected. The surficial sediment across the site are relatively heterogeneous, ranging from very dense clay to well-sorted sand. As a result, the ability of the surficial aquifer to transmit water was highly variable depending on location. Hydraulic conductivity values varied between 0.012 feet/day and 31 feet/day. Water chemistry varied by location within the surficial aquifer. High levels of metals, most notably aluminum, copper, and mercury, were observed at several locations. The occurrence of these metals is likely associated with the presence of the Duluth Complex which underlies the surficial deposits across much of the Site.

Aquifer testing was conducted on ten of the exploration borings completed in the Duluth Complex. In addition, water samples for laboratory analysis were collected from two of the 6-inch diameter exploration boreholes and a water supply well on site. Hydraulic conductivity values measured in the Duluth Complex boreholes ranged from 2.6 $x10^{-4}$ feet/day to 4.09 x 10^{-2} feet/day, with a geometric mean of 2.3 x 10^{-3} feet/day. These values fall within the range of hydraulic conductivities for the Duluth Complex reported by Siegel and Ericson (1980).

Water quality in the exploratory boreholes was variable. High levels of ammonia, aluminum, copper, and silver were found in both boreholes. The sample collected from the supply well had lower levels of metals. The occurrence of aluminum, copper, iron, and manganese in these boreholes are directly attributable to the Duluth Complex, in general, and the Copper-Nickel region of the complex in particular. The presence of ammonia in the deep boreholes may indicate that the water in the borehole came from the shallow surficial deposits. Ammonia is not typically found in deep bedrock systems but is common in wetland environments.

1.0 Introduction

This report has been prepared for PolyMet Mining, Corporation (PolyMet) by Barr Engineering Company (Barr) to document the results of the Hydrogeologic Investigation that was conducted at the PolyMet NorthMet mine site (the Mine Site) (Figure 1). The objective of this study was to provide information regarding:

- The ability of the Duluth Complex rocks and the surficial sediment at the Mine Site to transmit water into the proposed NorthMet pit (i.e., the transmissivity of the units);
- The quality of the water within the Duluth Complex rocks and the surficial sediment at the Mine Site; and
- Preliminary geotechnical characteristics of the surficial sediment.

This information is needed for permitting purposes (i.e. water appropriations permit, NPDES permit, permit to mine) and engineering design (i.e. stockpiles and wastewater treatment systems). These data will also likely be used in the Environmental Impact Statement.

1.1 Background

A scoping Environmental Assessment Worksheet (EAW) was submitted in June, 2005 for PolyMet's proposed NorthMet Mine and Ore Processing Facilities located near Hoyt Lakes, Minnesota. PolyMet plans to excavate and process the low grade polymetallic disseminated magmatic sulfide NorthMet deposit in northeastern Minnesota, approximately 6 miles south of the town of Babbitt and about 2 miles south of the operating Northshore Mining Company taconite open pit. Project plans call for the excavation of up to 32,000 tons of ore per day, using open-pit mining methods. Overburden and waste rock will be stripped and stockpiled. Processing of the ore will take place at the existing Cliffs Erie processing plant.

The NorthMet deposit is located in the Duluth Complex, a large mafic intrusion that was emplaced into flood basalts along a portion of the Middle Proterozoic Midcontinent Rift System. The NorthMet deposit is situated along the western edge of the Complex within the Partridge River intrusion, which has been subdivided into a least seven igneous stratigraphic units in drill core. All of these igneous layers exhibit a shallow dip (10º-25º) to the south-southeast. Underlying the Complex at NorthMet is the sedimentary Lower Proterozoic (1.8 million year old) Virginia Formation, which, in turn, is

underlain by the Biwabik Iron-Formation. The Biwabik will not be intersected in mining operations. The Virginia may be intersected along the northern footwall of the pit.

Extensive exploratory drilling has been conducted at the NorthMet deposit to establish the extent of the deposit. During the 2004/2005 winter, exploratory drilling was conducted to further define the geological model of the deposit. This drilling included NTW-sized (approximately 3-inch outer-diameter with a 2 inch rock core) exploratory borings and 6-inch outer-diameter (4 inch rock core) exploratory borings. The NTW borings were inclined approximately 60 to 70 degrees from vertical. The 6-inch borings were generally drilled in pairs, with one vertical boring and one inclined boring at most drill locations. Both the NTW and 6-inch borings were cased through the unconsolidated material.

1.2 Scope of Work

The Hydrogeologic Investigation presented in this report was designed to aid in the characterization of the Duluth Complex and the surficial sediment located at the Mine Site. Ten shallow borings were advanced through the surficial material, terminating in bedrock, at the Mine Site to characterize the surficial sediment via visual inspection and aquifer performance testing. Three of the shallow borings were converted to monitoring wells from which groundwater samples were collected.

Geotechnical samples were collected from the soil borings located beneath or near the proposed waste rock stockpiles. These samples were collected to provide preliminary information on the geotechnical properties of the surficial sediment.

Aquifer performance tests were conducted in ten exploratory borings at the Mine Site open to the Duluth Complex. Groundwater samples were collected from two of these borings, as well as from the water supply well at the Mine Site. This work provides information on the ability of the Duluth Complex and the surficial sediment to transmit water into the proposed NorthMet pit (i.e. the transmissivity of the units) and the quality of the water within these units.

1.3 Report Organization

This report is organized into four sections including this introduction. Section 2 summarizes the characterization of the surficial sediment, Section 3 summarizes the characterization of the Duluth Complex and Section 4 provides the investigation conclusions and recommendations.

2.0 Characterization of Surficial Sediment

Understanding the ability of the surficial sediment to transmit water into the pit and the chemical characteristics of that water is critical in understanding both the overall quality and quantity of water that can be expected in the pit. The information collected as part of this investigation will be used in conjunction with data collected during future investigations to help predict the effects the proposed mine will have on area surface water features. In addition, the geotechnical properties of the surficial sediment will have affect the design of the waste rock stockpiles and the ability of the sediment to be used as construction material.

All work was done in accordance with the *Hydrogeologic Investigation Work Plan for the PolyMet NorthMet Mine Site – March 29, 2005* (Work Plan) (Barr, 2005) except where noted below.

2.1 Field Activities and Data Collection Methodology

2.1.1 Soil Boring Advancement

Ten soil borings (SB-05-01 – SB-05-10) were installed by WDC using Rotasonic drilling techniques. Borings were installed at the proposed locations provided in the Work Plan (Figure 2). All soil borings were installed in accordance with the Work Plan specifications with the exception of SB-05-08. Difficult drilling conditions at this location (heaving sand and highly compacted till) required the boring to be terminated before bedrock was encountered. Due to the high bedrock elevation in boring SB-05-10, an additional boring (SB-05-10A) was advanced adjacent to SB-05-10 to allow installation of a temporary well. Soil samples were collected continuously to the termination depth of the boreholes using a 4-inch diameter, 5-foot long Rotasonic core barrel. Boring logs are included in Appendix A.

2.1.2 Geotechnical Sampling

Geotechnical samples were collected from four of the soil boring (SB-05-01, SB-05-04, SB-05-09 and SB-05-10). Four samples were delivered to Soil Engineering Testing (SET) for the analysis. Two samples were sent to the University of Minnesota, Soil Testing Laboratory for organic soil testing.

Parameters analyzed for include:

- Soil classification

- Natural water content
- Atterberg limits
- Particle size distribution
- Specific gravity
- Standard Proctor density
- Organic soil fertility test
- Permeability of remolded samples

Not all tests were run on all samples; tests were selected based on the soil classification of each sample. Identification of the samples tested are provided in Tables 3 and 4.

2.1.2 Well Installation

Permanent Well Installation

Three permanent monitoring wells (MW-05-02, MW-05-08, and MW-05-09) were constructed inside the Rotasonic borings of the same numbers (i.e., MW-05-02 was constructed in boring SB-05-02) (Figure 2). Wells were constructed using 2-inch diameter, number 10 slot PVC screens with 2-inch diameter PVC riser casing. Two of the wells, MW-05-08 and MW-05-09, were installed in accordance with the Work Plan specifications. The construction of MW-05-02 was modified from the Work Plan specifications due to the high bedrock elevation at the location. MW-05-02 was constructed with a one foot screen, rather than the proposed 5 or 10 foot screen. Coarse sand was added to a height of 0.5 feet above the screened interval. The remaining portion of the annulus was sealed with a combination of bentonite chips (1 foot) and neat cement (4 feet). Monitoring wells MW-05-08 and MW-05-09 were constructed with 10-foot and 5-foot long screens respectively. The remaining portion of the annulus was sealed with a combination of bentonite chips (2 feet) and neat cement (4.5 to 5 feet). All wells were completed above-grade with locking steel protective covers. Additional well construction information is provided on the boring logs in Appendix A.

Permanent monitoring wells were developed by surging and overpumping. The development process continued until the discharge appeared relatively free of suspended sediment. At MW-05-08, a total of 65 gallons (approximately 23 well volumes) were purged during development. This well was screened in a very fine sand and silt unit and contained large amounts of suspended sediment, and required extensive pumping and surging before clear discharge was obtained. Three well volumes were pumped from MW-05-02 and MW-05-09, since they did not contain as much suspended sediment as MW-05-08 and discharge appeared clear following purging of three well volumes.

Temporary Well Installation

Six temporary wells were installed in the remaining boreholes for the purpose of performing aquifer performance tests (see Section 2.1.3). Temporary wells were constructed using 5-foot long, 2-inch diameter PVC screens, with the exception of SB-05-06 and SB-05-10A, which were competed with 4-foot long screens due to shallow borehole depths at these locations. Where possible, the screened interval was placed across the stratigraphic unit in each borehole expected to have the highest transmissivity, based on field observations. At each location, the natural formation was allowed to collapse to an elevation of approximately two feet above the top of the screen. Bentonite chips were placed above the collapsed formation, as necessary, to act as a seal. Temporary well construction details are provided on the boring logs in Appendix A. Since the temporary wells were used only for aquifer testing and no analytical samples were collected, they were not developed.

2.1.3 Aquifer Performance Testing

In order to estimate the transmissivity of the surficial units, aquifer tests were performed at each permanent and temporary well location. Each aquifer test consisted of drawing the water level in the well down with a peristaltic or whale pump at a nearly constant rate, turning off and removing the pump assembly, and monitoring the recovery of the water level in the well. Water level recovery data were collected using a pressure transducer connected to a datalogger to allow for high frequency data collection. Data collection continued until at least 90% of the drawdown had been recovered. Water level data are included in Appendix B. Following completion of aquifer testing at the temporary well locations, the screens and risers were removed and the boreholes were backfilled with either bentonite chips or cement grout.

2.1.4 Groundwater Sampling

Groundwater samples were collected from the three permanent monitoring wells on March 23, 2005. The wells were developed during monitoring well construction, prior to sampling. All wells were purged prior to sampling, with purging considered complete when the field measurements stabilized or when three borehole volumes of water were evacuated. Field sampling data sheets are included in Appendix C.

Groundwater samples were collected and placed into laboratory-supplied containers and submitted to Northeast Technical Services (Virginia, Minnesota) for laboratory analysis of total metals, dissolved metals and general chemistry parameters. Groundwater laboratory parameters and methods are provided in Table 1.

2.2 Field Investigation Observations and Results

2.2.1 Geology

The surficial sediment across the site are relatively heterogeneous, ranging from very dense clay to well-sorted sand. In general, the surficial units are poorly sorted and contain numerous cobbles and boulders. A highly compacted gray clay unit with numerous pebbles was encountered just above the bedrock surface in several of the borings. Bedrock was encountered at depths ranging from four feet below grade at SB-B-10 to 17 feet below grade at SB-05-03. With the exception of SB-05-05, groundwater was encountered in all of the borings. The depth to groundwater across the site is generally less than five feet below grade. Details on the geology encountered in each boring are contained on the boring logs in Appendix A.

2.2.2 Geotechnical Testing

Geotechnical tests were run on soil samples collected from four of the soil borings at the Site. Identification of the samples tested and results of the testing are provided in Tables 3 and 4. Figure 2 shows the sampling locations. Test results are provided in Appendix E.

The test results indicate that there are silty sands (SM and SC-SM), clays (CL-ML), and organic soils (OH and PT/OH) on site. The silty sands and clay soils could be used for buffer material to level subgrade below a liner that may be required for reactive waste mine rock stockpiles. They could also be used for cover soils where needed. The silty sands are not permeable enough to use as drainage sand. The clay soils are too permeable to meet liner design requirements, but could meet cover design requirements. The organic soils could be salvaged and used, either as-is (with soil amendments) or mixed with other soils to enhance establishment of vegetation on stockpiles or in other locations, where needed.

2.2.3 Aquifer Performance Testing

Water-level recovery data were collected during each of the pumping tests. The data were analyzed using the Theis Recovery Method (Theis, 1935). This method calculates the transmissivity of a confined, homogeneous aquifer based on changes in water levels through time in a fully penetrating well due to constant pumping. This method has also been shown to be applicable in unconfined aquifers and in partially penetrating wells as long as the late time data is analyzed, as was done in this case (Kruseman and de Ridder, 2000). Because the tests were single-well test, it was not possible to obtain storativity values. Transmissivities were converted to average hydraulic

conductivities by dividing each transmissivity value by the aquifer thickness at the location. Aquifer-test data are presented in Table 2 and are shown in Appendix B.

Hydraulic conductivity values varied between 31 ft/day and 0.012 ft/day. The largest values of hydraulic conductivities were measured in MW-05-02 (31 ft/day) and SB-05-01 (26 ft/day). The hydraulic conductivity values measured in MW-05-02 is higher than would be expected considering the well is screened in sandy clay at the contact of the clay and the underlying Duluth Complex. The remaining hydraulic conductivity values fall within the ranges of values expected for the given material that was tested (Freeze and Cherry, 1979).

In several of the borings, thick sequences of sand were encountered (MW-05-08, MW-05-09, SB-05-07). However, aquifer tests at these locations found hydraulic conductivities (0.061, 0.027, 3.6 ft/day respectively) that were on the low end of the range for silty sand. Hydraulic conductivity values for silty sand generally range from 0.01 to 100 ft/day (Freeze and Cherry, 1979).

2.3 Analytical Results

Groundwater samples were collected from the three Site monitoring wells (MW-05-02, MW-05-08, MW-05-09) in March 2005. The analytical results are presented in Table 5. Since the ultimate fate of the mine pit water is not known, analytical results are compared to the Minnesota Surface Water Quality Class 2B Chronic and the Lake Superior Basin Water Quality Class 2B Chronic criteria for the sake of comparison. The Minnesota Surface Water Quality Class 2B Chronic standards are designed to be protective of surface water used for recreation and support cool or warm water sport or commercial fish and associated aquatic life. Class 2B surface water is not protected as a drinking water source. The Lake Superior Basin water quality standards protect Class 2B waters within the Lake Superior watershed. Because a receiving water has not been identified at this time, a hardness of 50 mg/l was used to derive the criteria.

The water sample from well MW-05-02 exceeded criteria for ammonia (240 ug/l), pH (10), aluminum (322 ug/l), and copper (11.2 ug/l). The sample from MW-05-08 exceeded criteria for aluminum (1,040 ug/l), copper (10 ug/l), and mercury (0.0053 ug/L). The sample from MW-05-09 exceeded criteria for aluminum (4,640 ug/L), chromium (28.6 ug/l), cobalt (5.4 ug/l), copper (72.2 ug/l), lead (5.6 ug/l), and mercury (0.0181 ug/l).

3.0 Characterization of the Duluth Complex

Understanding the ability of the Duluth Complex to transmit water into the proposed mine pit and the quality of that water is critical in understanding both the overall quality and quantity of future pit water. Exploratory borings at the Site were used to test the transmissivity of the Duluth Complex and to collect groundwater samples representative of the portion of the Complex that will be intersected by the proposed mine pit.

All work was done in accordance with the *Hydrogeologic Investigation Work Plan for the PolyMet NorthMet Mine Site – March 29, 2005* (Work Plan) (Barr, 2005) except where noted below.

3.1 Field Activities and Data Collection Methodology

3.1.1 Aquifer Performance Testing

Aquifer performance tests were conducted in 10 of the new exploratory boreholes drilled during 2005 by Boart Longyear and Idea Drilling at the Mine Site. Four of the tests were conducted in 6-inch diameter boreholes and six of the tests were conducted in NTW boreholes (Figure 2). Each aquifer test consisted of dewatering the borehole to create approximately 200 feet of drawdown and measuring the recovery of the water level following dewatering.

The 6-inch boreholes were dewatered using an electric pump with the intake set at a depth of 200 feet below ground surface. The pumping rates were held nearly constant for the period of dewatering, which ranged from approximately 40 to 80 minutes. Following dewatering, the pump was shut off and a pressure transducer connected to a datalogger was installed in the borehole to record water-level recovery data. With the exception of boring 05-404M, the pump assembly remained in the borehole during the water-level recovery period. Because boring 05-404M was an angled boring, it was not possible to install the pressure transducer without removing the pump assembly.

The NTW boreholes were dewatered by inserting tubing into the well to a depth of approximately 200 feet and blowing high-pressure air supplied by an air compressor into the borehole to displace water from the borehole. This process allowed for the rapid removal (less than one minute) of water from the borehole resulting in a slug-test. Following dewatering, the tubing assembly was quickly removed from the borehole, a pressure transducer was installed, and the water level was allowed to recover. Additional details on the testing are provided in Table 4.

3.1.2 Groundwater Sampling

Groundwater samples were collected from three of the deep borings at the site. Two of the samples were collected from 6-in diameter exploratory boreholes. The remaining sample was collected from the water supply well (Unique Well Number 717972). This well is open to both the Duluth Complex (20-150 feet below ground surface) and the Virginia Formation (150-200 feet below ground surface). The 6-inch boreholes contained large quantities of drilling fluid and were developed to the extent possible by overpumping prior to sampling. The sample from 05-401M was collected after the borehole had been dewatered 5 times despite the fact that it still had a cloudy appearance. Following development, groundwater samples were collected into laboratory supplied containers and submitted to Northeast Technical Services for laboratory analysis of total metals, dissolved metals and general chemistry parameters. Groundwater laboratory parameters and methods are provided in Table 1.

3.2 Field Investigation Observations and Results

Aquifer Performance Testing

Results from the ten aquifer performance tests that were conducted in the exploratory borings are shown in Table 6. Data and results from aquifer testing are presented in Appendix B. The aquifer tests that were conducted in the 6-inch diameter boreholes (05-401M, 05-404M, 05-407M, 05-411M) were analyzed using the Moench solution for a pumping test in a fractured aquifer with slab blocks (Moench, 1984). The Moench solution (1984) is an analytical solution for predicting water-level displacements in response to pumping in a fractured aquifer assuming a double-porosity model with slab-shaped matrix blocks with fracture skin and wellbore skin. The method solves for the hydraulic conductivity and storage for both the fractures and the rock matrix and provides information on the wellbore skin and fracture skin.

The aquifer tests that were conducted in the NTW holes were analyzed using the Bouwer-Rice solution for a slug test (Bouwer and Rice, 1976), with the exception of the test conducted in borehole 05-414C. At this location, the Bouwer and Rice solution could not match the observed water level data. That is, the Bouwer and Rice solution is a straight line solution, requiring data plotted on log paper lie on a straight line. The data from borehole 05-414C did not meat this requirement. This test was instead analyzed using the KGS model (Hyder et al., 1994). Unlike the Bouwer and Rice solution, the KGS model assumes that flow into the well is unsteady.

Hydraulic conductivity values measured in the Duluth Complex boreholes ranged from 2.6×10^{-4} feet/day to 4.1×10^{-2} feet/day, with a geometric mean of 2.3×10^{-3} feet/day. It is worth noting that

eight of the ten boreholes terminate in the Virginia Formation, which is generally more permeable. However, because less the 5% of the borehole length was within the Virginia Formation, it likely does not significantly affect the results of the aquifer testing.

These values fall within the expected range of hydraulic conductivities for the Duluth Complex. Siegel and Ericson (1980) report specific capacities of 0.11 and 0.02 (gal/min)/ft for two Duluth Complex wells located between 10-20 miles northeast of the Site. Hydraulic conductivities can be estimated from this data using the methodology of Razack and Huntley (1991). The results are hydraulic conductivity values of 1.6 $x10^{-2}$ feet/day and 2.8 $x10^{-3}$ feet/day respectively.

3.3 Analytical Results

Groundwater samples were collected from two 6-inch diameter exploratory boreholes open to the Duluth Complex (05-407M and 05-401M) and a water supply well at the site open to the Duluth Complex and the Virginia Formation (Unique Well Number 717972) in March 2005. The analytical results are presented in Table 7. Since the ultimate fate of the mine pit water is not known, analytical results are compared to the Minnesota Surface Water Quality Class 2B Chronic and the Lake Superior Basin Water Quality Class 2B Chronic criteria for the sake of comparison. Because a receiving water has not been identified at this time, a hardness of 50 mg/l was used to derive the criteria.

The water sample from boring 05-407M exceeded the criteria for ammonia (1,900 ug/l), pH (9.8), aluminum (39,900 ug/l), chromium (42 ug/l), cobalt (19.9 ug/l), copper (587 ug/l), lead (9.5 ug/l), mercury (0.0034 ug/l), nickel (172 ug/l), and silver (7.4 ug/l). The sample from boring 05-401M exceeded criteria for ammonia (610 ug/l), aluminum (3170 ug/l), copper (53.3 ug/l), and silver (1.1 ug/l).

4.0 Quality Assurance

A quality assurance and quality control review was performed on the analytical results from the sampling event. This review was performed in accordance with the Barr Engineering Standard Operating Procedure for data validation, which is based on "The National Functional Guidelines for Organic and Inorganic Data Review" (EPA 1999/2004). All methyl mercury analysis was performed by Frontier Geosciences, Inc. located in Seattle, Washington and all other analysis was performed by Northeast Technical Services located in Virginia, Minnesota.

Field procedures were evaluated using an equipment blank (mercury only) and a trip blank (methyl mercury only) and laboratory procedures were evaluated utilizing technical holding times, accuracy and precision data, masked duplicate samples and data package completeness.

The equipment blank had a detection of mercury near the reporting limit. All data within five times the blank value were qualified as potentially false positive. The trip blank was non-detect for methyl mercury. Technical holding times were evaluated for each sample and target parameter, based on the EPA recommendations listed in 40 CFR SW8-46 "Test Methods for Evaluating Hazardous Waste". All holding times were met. No laboratory accuracy and precision data were included in the data packages for examination, however the laboratory indicated that the laboratory control sample (LCS) for molybdenum and the matrix spike (MS) for potassium were not within control limits. All molybdenum data associated with this LCS were qualified and should be considered potentially biased low. All potassium data associated with this MS were qualified and should be considered potentially biased high. No remaining data was qualified.

One masked duplicate was collected and submitted to the laboratory with the project samples. The precision between this duplicate and the original sample was evaluated by comparing the data and calculating the relative percent difference (RPD) according the equation below.

$$RPD = \frac{\text{Amount in Spike 1} - \text{Amount in Spike 2}}{0.5(\text{Amount in Spike 1} + \text{Amount in Spike 2})} \times 100$$

The boron analysis showed the sample at <3.5µg/L while its masked duplicate had a value of 3.8µg/L. In addition, the sample had a nitrate plus nitrite value of 0.1 mg/L while the masked duplicate had a value of 0.9mg/L. Since all of these values are near the analytical detection limit, it

does not represent a large data variability problem and no data was qualified. All remaining RPD's fell within acceptable laboratory control limits (<30%) for all remaining target compounds.

Data completeness is evaluated by comparing the analysis requested with the data package as received. The laboratory chain of custody listed the sample collection date as 2/10/05 when the actual date was 3/10/05. The laboratory report contains the correct date. All data was received complete.

All data met the data project requirements and is deemed acceptable with the previously mentioned qualifications for the purposes of this project.

5.0 Summary and Conclusions

The purpose of the Hydrogeologic Investigation was to gather information on the ability of the surficial sediment and the Duluth Complex to transmit water to the proposed NorthMet pit, to characterize the quality of the water found in these formations, and to gather preliminary information on the geotechnical properties of the surficial sediment.

5.1 Surficial Aquifer

Ten shallow borings were advanced through the surficial sediment at the Site, terminating in bedrock, in order to visually inspect the sediment encountered and to perform aquifer performance tests. Three of the surficial aquifer borings were converted to monitoring wells, from which groundwater samples were collected. The surficial sediment across the site are relatively heterogeneous, ranging from very dense clay to well-sorted sand. As a result, the ability of the surficial aquifer to transmit water was highly variable depending on location. Hydraulic conductivity values varied between 0.012 feet/day and 31 feet/day. With the exception of MW-05-02, values of hydraulic conductivity determined at each location were within the expected range of values for the material these wells were screened in.

Water chemistry varied by location within the surficial aquifer. Water quality criteria (2B Cronic) were exceeded at more than one location for a select group of metals, most notably aluminum, copper, and mercury. The occurrence of these metals is likely associated with the presence of the Duluth-Complex bedrock as described further in Section 5.2.

5.2 Duluth Complex

Aquifer testing was conducted on ten of the exploration borings completed in the Duluth Complex. In addition, water samples for laboratory analysis were collected from two of the 6-inch diameter exploration boreholes and the water supply well. Hydraulic conductivity values measured in the Duluth Complex boreholes ranged from 2.6×10^{-4} feet/day to 4.1×10^{-2} feet/day, with a geometric mean of 2.3×10^{-3} feet/day. These values fall within the range of hydraulic conductivities for the Duluth Complex reported by Siegel and Ericson (1980).

Water quality in the exploratory boreholes was variable. Water quality criteria were exceeded for ammonia, aluminum, copper, and silver in both boreholes. The sample collected from the supply

well did not exceed water quality standards. The occurrence of aluminum, copper, iron, and manganese in these boreholes are directly attributable to the Duluth Complex, in general, and the Copper-Nickel region of the complex in particular. These results are consistent with the findings presented in the U.S. Geological Survey Copper-Nickel Study Region report (Siegel and Ericson, 1980), which found elevated copper (up to 190 ug/L), cobalt (up to 46 ug/L), and nickel (up to 120 ug/L) concentrations in groundwater samples collected from the surficial material directly over the mineralized zone of the Duluth Complex. The study also found elevated concentrations of iron (up to 67 mg/L), aluminum (up to 200 ug/L), and manganese (up to 26 mg/L) in the region (Siegel and Ericson, 1980). The presence of ammonia in the deep boreholes may indicate that the water in the borehole came from the shallow surficial deposits. Ammonia is not typically found in deep bedrock systems but is common in wetland environments.

5.3 Conclusions

The results of this study provide information on the hydrogeologic properties of the surficial aquifer system and the Duluth Complex. The data collected as part of this study are consistent with the assumptions that were used in the initial mine pit water balance that was presented in the EAW. That is, the average value of hydraulic conductivity of the Duluth Complex found as part of this study (0.0023 feet/day) is similar to the lower value that was used in the preliminary SEEP modeling of the pits (0.0017 feet/day). In addition, the preliminary conceptual model assumed that the surficial material is relatively thin (less than 20 feet) and does not have a high bulk transmissivity. This is consistent with the finding from this investigation, where the average depth to bedrock was approximately 13.5 feet and the hydraulic conductivity ranged from 31 to 0.012 feet/day.

Additional data is needed to determine the overall water balance for the mine pit. A Phase II Hydrogeologic Investigation, conducted in the winter of 2005/2006, will help determine the aquifer properties for the Virginia Formation, which will likely be encountered along portions of the northern mine pit wall. This investigation involved aquifer tests and groundwater sampling. Following the completion of the Phase II Hydrogeologic Investigation, a more detailed water balance for the mine pit will be conducted.

References

Barr Engineering Company (Barr), 2005. Hydrogeologic Investigation Work Plan for the PolyMet NorthMet Mine Site. Prepared on behalf of PolyMet Mining, Inc., March 29, 2005.

Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.

Freeze, R.A., and J.A. Cherry, 1979. Groundwater. Englewood Cliffs, N.J.: Prentice Hall.

Kruseman, G.P. and N.A. DeRidder, 2000. Analysis and Evaluation of Pumping Test Data (2nd ed.), Publication 47, Intern. Inst. for Land Reclamation and Improvement, Wageningen, The Netherlands, 370p.

Hyder, Z, J.J. Butler, Jr., C.D. McElwee and W. Liu, 1994. Slug tests in partially penetrating wells, Water Resources Research, vol. 30, no. 11, pp. 2945-2957.

Moench, A.F., 1984. Double-porosity models for a fissured groundwater reservoir with fracture skin, Water Resources Research, vol. 20, no. 7, pp. 831-846.

Razack, M. and D. Huntley, 1991. Assessing transmissivity from specific capacity in a large and heterogeneous alluvial aquifer, Ground Water, vol. 29, no. 6, pp. 856-861.

Siegel, D.I., and D.W. Ericson, 1980. Hydrology and water quality of the copper-nickel study region, Northeastern Minnesota, U.S. Geological Survey, Water-Resources Investigations 80-739.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

Tables

Table 1
Groundwater Analytical
Parameters with Analysis Method

Description	Method
Alkalinity, Total as CaCO3	EPA 310.1
Carbon, Total Organic	EPA 415.1
Chemical Oxygen Demand	STD METH 5220D, 18TH ED
Chloride	EPA 325.2
Cyanide Total	EPA 335.2
Fluoride	EPA 340.1
Hardness, Total (calculated)	EPA 200.7
Nitrogen, Ammonia	EPA 350.1
Nitrogen, Nitrate + Nitrite	EPA 353.2
pH	EPA 150.1
Phosphorus, Total	EPA 365.2
Sulfate	EPA 375.4
Aluminum, Total	EPA 200.7
Aluminum, Dissolved	EPA 200.7
Antimony, Total	EPA 204.2
Arsenic, Total	EPA 200.8
Barium, Total	EPA 200.7
Beryllium, Total	EPA 210.2
Boron, Total	EPA 200.7
Cadmium, Total	EPA 213.2
Cadmium, Dissolved	EPA 213.2
Calcium, Total	EPA 200.7
Chromium, Total	EPA 218.2
Chromium, Dissolved	EPA 218.2
Cobalt, Total	EPA 219.2

Description	Method
Copper, Total	EPA 220.2
Copper, Dissolved	EPA 220.2
Iron, Total	EPA 200.7
Lead, Total	EPA 7421
Magnesium, Total	EPA 200.7
Manganese, Total	EPA 200.7
Mercury, Low Level Total	EPA 1631E
Methyl Mercury, Total	EPA 1631E
Molybdenum, Total	EPA 246.2
Molybdenum, Dissolved	EPA 246.2
Nickel, Total	EPA 249.2
Nickel, Dissolved	EPA 249.2
Palladium, Total	EPA 200.7
Platinum, Total	EPA 200.7
Potassium, Total	EPA 200.7
Selenium, Total	EPA 270.2
Selenium, Dissolved	EPA 270.2
Silver, Total	EPA 272.2
Silver, Dissolved	EPA 272.2
Sodium, Total	EPA 200.7
Strontium, Total	EPA 200.7
Thallium, Total	EPA 279.2
Titanium, Total	EPA 283.2
Zinc, Total	EPA 200.7
Zinc, Dissolved	EPA 200.7

Table 2
Surficial Aquifer Test Data
PolyMet Mining, Inc.

Location	Material	Well depth (ft)*	Screen length (ft)	Aquifer thickness (ft)	Static		Test start		Pumping duration (min)	Pumping rate (gpm)	Initial displacement (ft)	Transmissivity (ft^2/day)	Hydraulic Conductivity (ft/day)
					DTGW (ft)*	Water column (ft)	DTGW (ft)*	Water column (ft)					
SB-05-01	OL	15.7	5	12.25	3.45	12.25	3.60	12.10	17	1.6	0.15	322.5	26
MW-05-02	CL	8.77	1	2.25	6.52	2.25	7.55	1.22	11	0.5	1.03	68.82	31
SB-05-03	CL/SM	8.9	5	8.12	5.28	3.62	8.9	0.00	3	0.5	3.62	0.1131	0.014
SB-05-04	DLCX	21	5	5	1.6	19.4	6.7	14.30	3	0.45	5.10	0.1642	0.033
SB-05-06	CL	12.65	4	12.65	1	11.65	12.65	0	8	0.5	11.65	0.1556	0.012
SB-05-07	SM/SC	13.75	5	11.77	1.98	11.77	2.99	10.76	16	0.5	1.01	42.2	3.6
MW-05-08	SP	20.55	10	18.84	3.21	17.34	20.55	0	7	0.6	17.34	1.143	0.061
MW-05-09	SP/SM	16.15	5	6.04	10.11	6.04	15.05	1.1	9	0.5	4.94	0.1644	0.027
SB-05-10	SM/CL	8	4	4.44	3.56	4.44	8	0	3	0.5	4.44	0.4927	0.11

* Measured from top of casing

Table 3 - Geotechnical Test Results, Classification, Water Content, Atterberg Limits, Specific Gravity, and Organic Matter

Sample		Soil Classifi-cation	Water Content %	Atterberg Limits			Specific Gravity	Organic Matter %
Boring No.	Depth (ft below ground)			Liquid Limit %	Plastic Limit %	Plasticity Index		
SB-05-01	4.0 – 5.0	OH	NP	NP	NP	NP	NP	9.8
SB-05-01	6.0 – 8.0	PT/OH	NP	NP	NP	NP	NP	68.7
SB-05-04	2.0 – 7.5	CL-ML	22.0	25.6	20.0	5.6	2.78	NP
SB-05-04	8.5 – 15.5	SM	6.0	11.1	10.0	1.1	2.76	NP
SB-05-09	8.5 – 12.5	SM	7.9	NP	NP	NP	2.76	NP
SB-05-10	1.0 – 4.0	SM/SC-SM	11.6	15.0	12.2	2.8	2.76	NP

NP = Not Performed

Table 4 - Geotechnical Test Results, Proctor and Permeability

Sample		Standard Proctor Analysis		Permeability Analysis		
Boring No.	Depth (ft below ground)	Optimum Water Content %	Max. Dry Density lb/cf	Water Content as Tested %	Dry Density as Tested lb/cf	Permeability cm/sec
SB-05-04	2.0 – 7.5	13.5	119.1	16.1	112.9	8.7×10^{-8}
SB-05-04	8.5 – 15.5	7.1	136.8	9.6	129.2	6.0×10^{-7}
SB-05-09	8.5 – 12.5	7.2	134.7	9.6	127.7	1.5×10^{-6}
SB-05-10	1.0 – 4.0	9.4	131.4	12.0	125.3	1.5×10^{-7}

Table 5
Surficial Aquifer Analytical Data Summary
Polymet Mining, Inc.
(concentrations in ug/L, unless noted otherwise)

Location Date Dup	MN Surface Water Class 2B Chronic (1)	MW-05-02 3/23/2005	MW-05-08 3/23/2005	MW-05-08 3/23/2005 DUP	MW-05-09 3/23/2005
Exceedance Key	**Bold**				
General Parameters					
Alkalinity, total, mg/L	--	88.3	72.8	65.2	47
Chemical Oxygen Demand, mg/L	--	12.4	12.4	8.8	6.9
Chloride, mg/L	230	1.3	1.1	1.3	5.5
Cyanide	--	<20	<20	<20	<20
Fluoride, mg/L	--	0.21	0.19	0.19	0.1
Hardness, total, mg/L	--	84.8	64.3	66.1	53.4
Nitrate + Nitrite	--	330	310	900	<100
Nitrogen, ammonia as N	40	**240**	<100	<100	<100
Phosphorus total	--	140	170	160	470
Sulfate, mg/L	--	10.8	21.2	20.3	13.8
pH, standard units	6.5 - 9.0 PH	**10**	7.4	7.7	7.5
Carbon, total organic, mg/L	--	8	3.8	3.3	4.6
Metals					
Aluminum	125	**322**	**1040**	**1300**	**4640**
Antimony	31	<3	<3	<3	<3
Arsenic	53	3.2	4.4	3.1	3.4
Barium	--	<10	32.5	32	90.7
Beryllium	--	<0.2	<0.2	<0.2	0.3
Boron	--	<35	<35	38	40.2
Cadmium	0.66 HD	<0.2	<0.2	<0.2	<0.2
Calcium	--	30100	14500	14900	12100
Chromium	11 CR6	1.2	6.1	4.8	**28.6**
Cobalt	5.0	<1	1.8	1.6	**5.4**
Copper	5.2 HD	**11.2**	**10**	**7.8**	**72.2**
Iron	--	350	1740	1940	6400
Lead	1.3 HD	<1	<1	<1	**5.6**
Magnesium	--	2300	6800	7000	5700
Manganese	--	<30	220	220	330
Mercury	0.0013	<0.002	**0.0053**	**0.0036**	**0.0181**
Mercury methyl	--	<0.000025	<0.000025	<0.000025	0.000043
Molybdenum	--	16.1 *	35.6 *	33.1 *	12.4 *
Nickel	29 HD	<2	7.9	6.2	9.6
Palladium	--	<25	<25	<25	<25
Platinum	--	<25	<25	<25	<25
Potassium	--	1600 *	1600 *	1600 *	2100 *
Selenium	5.0	<2	<2	<2	<2
Silver	1.0 HD	<1	<1	<1	<1
Sodium	--	11900	15700	13500	9500
Strontium	--	191	35.9	37.1	37.7
Thallium	0.56	<2	<2	<2	<2
Titanium	--	30.7	113	82.6	620
Zinc	59 HD	<10	<10	<10	11.8
Dissolved Metals					
Aluminum, dissolved	--	44.6	214	132	910
Cadmium, dissolved	--	<0.2	<0.2	<0.2	<0.2
Chromium, dissolved	--	<1	<1	<1	2.5
Copper, dissolved	--	8	6.4	2.3	18.2
Molybdenum dissolved	--	13.1	34.4	32.9	<5
Nickel, dissolved	--	<2	<2	<2	<2
Selenium, dissolved	--	<2	<2	<2	<2
Silver, dissolved	--	<1	<1	<1	<1
Zinc, dissolved	--	<10	<10	<10	<10

1/17/2006 3:59 PM
P:\23\69\862\Lims\282_MWdatasum_051005.xls

Table 5
Surficial Aquifer Analytical Data Summary
Polymet Mining, Inc.
Footnotes

--	No criteria.
(1)	Criteria represents most conservative value as noted in Minnesota Rules Chapter 7050.0222 and 7052.0100.
*	Estimated value, QA/QC criteria not met.
CR6	Value represents the criteria for Chromium, hexavalent.
HD	Hardness dependent. The specific analyte should be referenced in Minnesota Rules Chapter 7050.0222 and 7052.0100 for specific exp. calculations. The values reported are assuming a hardness of 50 mg/L.
PH	Not less than 6.5 nor greater than 9.0.
DUP	Duplicate sample.
	The data was also compared to, and did not exceed, EPA Maximum Contaminant Levels criteria.

Table 6
Duluth Complex Aquifer Test Data
PolyMet Mining, Inc.

Hole Number	UTM Northing	UTM Easting	Total Depth (ft)	Overburden Thickness (ft)	Duluth Thickness (ft)	Virginia Thickness (ft)	Azimuth	Dip (from horizontal)	Hydraulic Conductivity (ft/day)
05-401M	5275255.38	578872.88	349	0	338	11	0	-90	0.0036
05-404M	5275168.83	578761.26	349	0	349	0	326	-70	0.01
05-407M	5274194.69	576528.16	354	8	346	0	0	-90	0.0084
05-411M	5273507.48	576265.73	639	13	626	0	0	-90	0.00084
05-405C	5273410.38	575952.21	769	33	721	15	326	-70	0.00067
05-406C	5273476.35	576160.58	757	7	737	13	326	-65	0.00026
05-409C	5273582.83	575945.37	488	18	457	13	326	-65	0.041
05-410C	5273361.33	575856.36	737	8	718	11	326	-65	0.00042
05-413C	5273687.08	576017.46	388	14	372	2	326	-60	0.012
05-414C	5273331.66	576264.35	1438	0	1266	172	326	-65	0.00039
								Minimum	**0.00026**
								Maximum	**0.041**
								Geo. Mean	**0.0023**

Table 7
Bedrock Aquifer Analytical Data Summary
Polymet Mining, Inc.
(concentrations in ug/L, unless noted otherwise)

Location Date Dup	MN Surface Water Class 2B Chronic (1)	05-407M 3/10/2005	05-401M 3/10/2005	Supply Well 3/23/2005
Exceedance Key	**Bold**			
General Parameters				
Alkalinity, total, mg/L	--	93.7	106	95.2
Chemical Oxygen Demand, mg/L	--	33.9	17.7	9.7
Chloride, mg/L	230	2.7	1.7	0.5
Cyanide	--	<20	<20	<20
Fluoride, mg/L	--	0.49	0.14	0.25
Hardness, total, mg/L	--	149	61.7	60.4
Nitrate + Nitrite	--	<100	<100	<100
Nitrogen, ammonia as N	40	**1900**	**610**	<100
Phosphorus total	--	1100	200	<100
Sulfate, mg/L	--	24.7	13.6	4.4
pH, standard units	6.5 - 9.0 PH	**9.8**	8.1	8.7
Carbon, total organic, mg/L	--	2.6	3.9	3.9
Metals				
Aluminum	125	**39900**	**3170**	<25
Antimony	31	<3	<3	<3
Arsenic	53	4.4	<2	<2
Barium	--	92.1	<10	<10
Beryllium	--	0.8	<0.2	<0.2
Boron	--	183	<35	128
Cadmium	0.66 HD	<0.2	<0.2	<0.2
Calcium	--	38500	20500	12000
Chromium	11 CR6	**42**	4.6	<1
Cobalt	5.0	**19.9**	2.2	<1
Copper	5.2 HD	**587**	**53.3**	<2
Iron	--	24500	3050	60
Lead	1.3 HD	**9.5**	<1	<1
Magnesium	--	12800	12200	7400
Manganese	--	200	140	<30
Mercury	0.0013	**0.0034**	0.001 b	<0.0005
Mercury methyl	--	<0.000025	<0.000025	<0.000025
Molybdenum	--	<5	<5	<5 *
Nickel	29 HD	**172**	18.3	<2
Palladium	--	<50 c	<25	<25
Platinum	--	<25	<25	<25
Potassium	--	5200	1900	1400 *
Selenium	5.0	<2	<2	<2
Silver	1.0 HD	**7.4**	**1.1**	<1
Sodium	--	38200	8600	20200
Strontium	--	143	48	46.5
Thallium	0.56	<2	<2	<2
Titanium	--	765	66.8	<10
Zinc	59 HD	46.8	<10	<10
Dissolved Metals				
Aluminum, dissolved	--	126	62.5	<25
Cadmium, dissolved	--	<0.2	<0.2	<0.2
Chromium, dissolved	--	<1	<1	<1
Copper, dissolved	--	<2	2.2	<2
Molybdenum dissolved	--	<5	<5	<5
Nickel, dissolved	--	<2	6.2	<2
Selenium, dissolved	--	<2	<2	<2
Silver, dissolved	--	<1	<1	<1
Zinc, dissolved	--	<10	<10	<10

Table 7
Bedrock Aquifer Analytical Data Summary
Polymet Mining, Inc.
Footnotes

--	No criteria.
(1)	Criteria represents most conservative value as noted in Minnesota Rules Chapter 7050.0222 and 7052.0100.
*	Estimated value, QA/QC criteria not met.
b	Potential false positive value based on blank data validation procedure.
c	Coeluting compound.
CR6	Value represents the criteria for Chromium, hexavalent.
HD	Hardness dependent. The specific analyte should be referenced in Minnesota Rules Chapter 7050.0222 and 7052.0100 for specific exp. calculations. The values reported are assuming a hardness of 50 mg/L.
PH	Not less than 6.5 nor greater than 9.0.
	The data was also compared to, and did not exceed, EPA Maximum Contaminant Levels criteria.

Figures

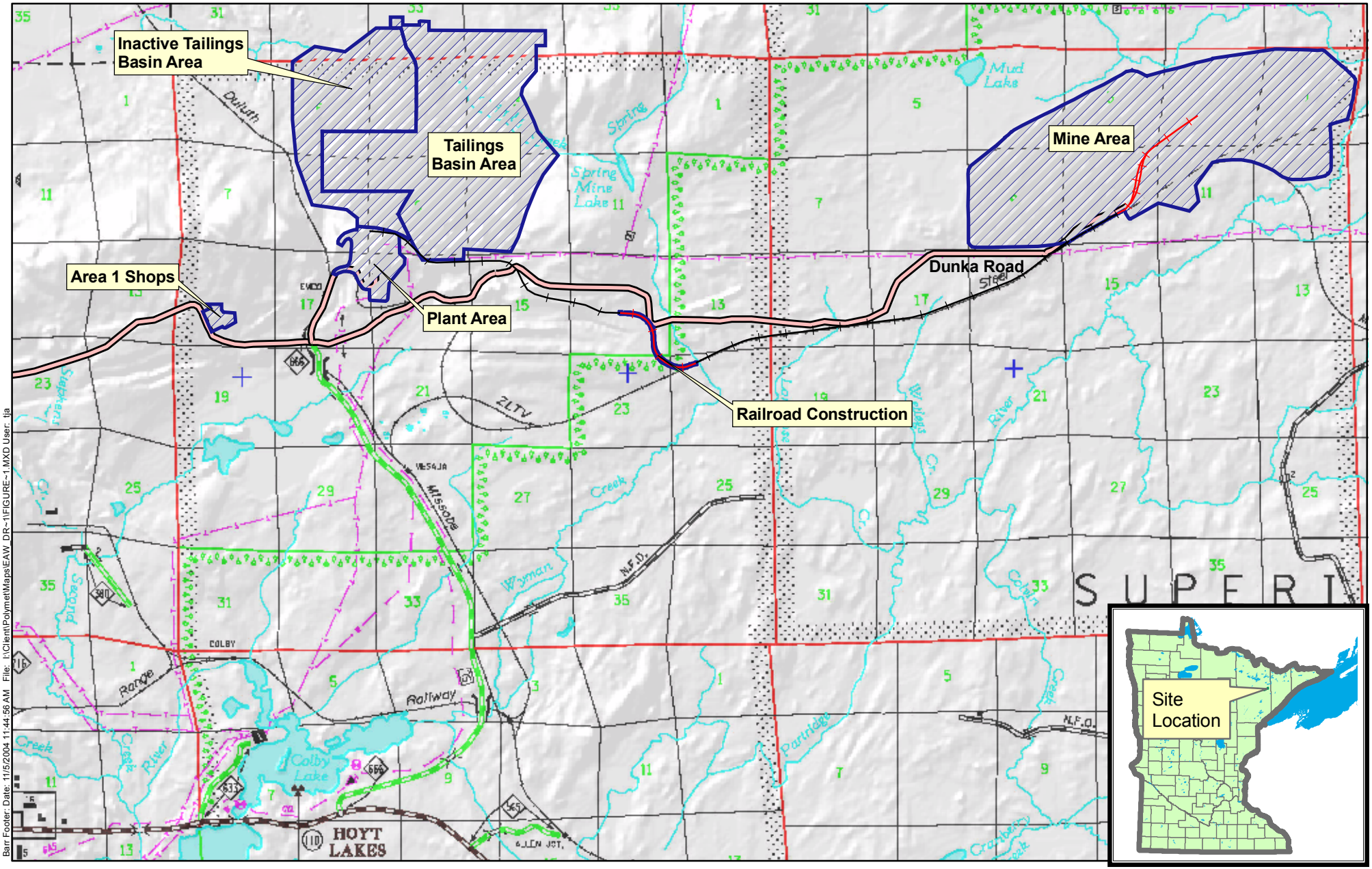
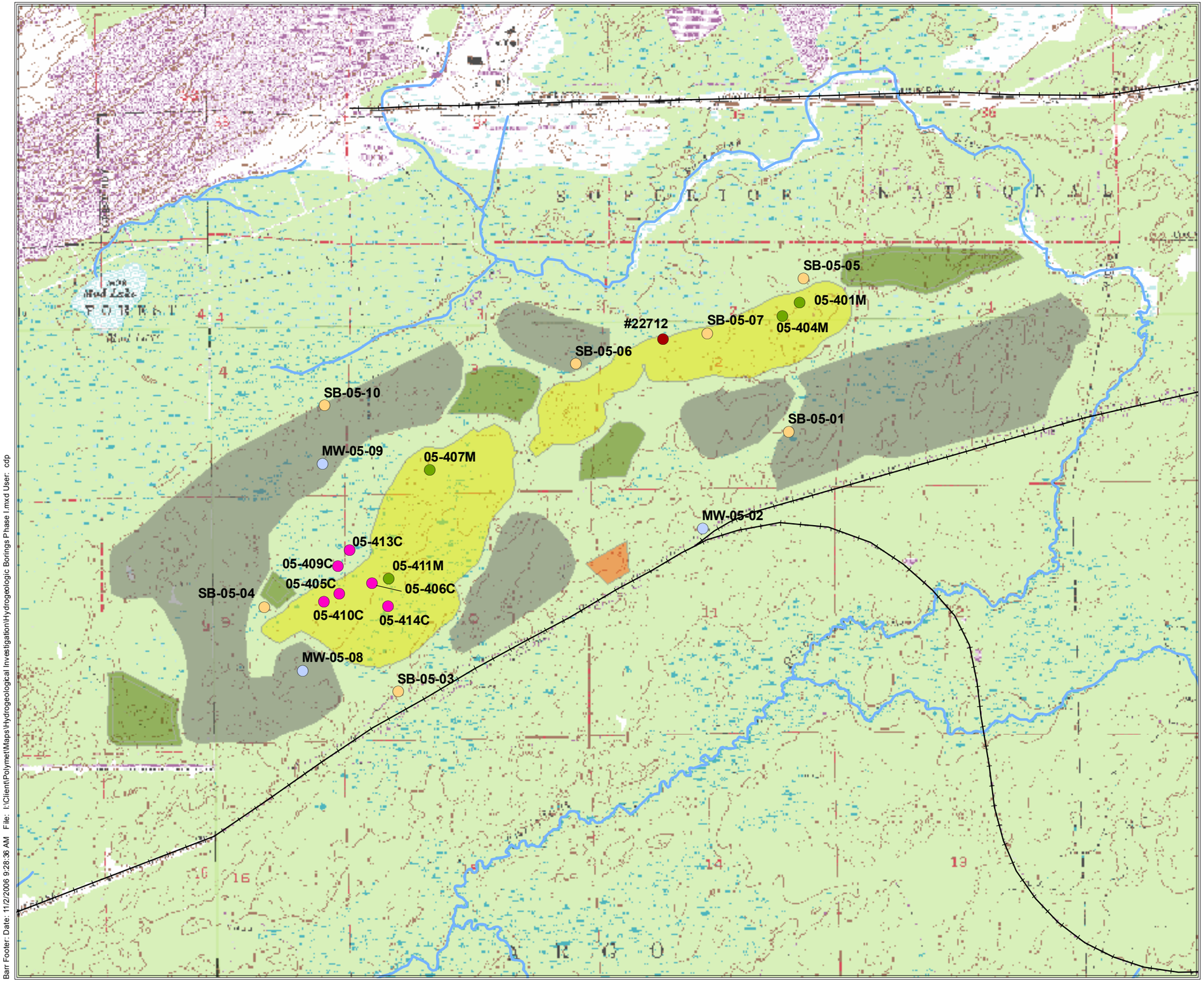


Figure 1

SITE LOCATION MAP
PolyMet Mining, Inc.
Hoyt Lakes, Minnesota



Water Well
6-inch
NTW
Soil Boring
Monitoring Well

Potential Future Mine Features

Loadout Pocket
Overburden Stockpiles
Mine Pits
Rock Stockpiles

(Mine features based on August 2006 design)

0 1,250 2,500 5,000 Feet

Allen, Babbitt, Babbitt SW, and Isaac Lake
7.5 Minute USGS Quadrangles

Figure 2

SITE LAYOUT WITH MARCH 2005 HYDROGEOLOGIC INVESTIGATION LOCATIONS
PolyMet Mining, Inc.
Hoyt Lakes, Minnesota

Barr Footer: Date: 11/2/2006 9:28:36 AM File: I:\Client\Polymet\Maps\Hydrogeological Investigation\Hydrogeologic Borings Phase I.mxd User: cdp

Appendices

Appendix A

LOG OF WELL MW-05-02

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/14/05 Ended 3/15/05
Elevation --
Location NorthMet Mine Site
Logged By Jere Mohr
Total Depth 18.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	DEPTH FEET
					CL		Medium brown sandy clay, upper 1' wet, then moist, very moist at 5'. Chunks of black crystalline rock at 5'.	PRO. CASING Diameter: **6 inches** Type: **Steel** Interval: **0-4 ft bgs** RISER CASING Diameter: **2 inches** Type: **PVC** Interval: **0-5 ft bgs** GROUT Type: **Cement** Interval: **0-4 ft bgs** SEAL Type: **Bentonite** Interval: **4-5 ft bgs** SANDPACK Type: **Red Flint** Interval: **5-6.5 ft bgs** SCREEN Diameter: **2 inches** Type: **PVC** Interval: **5.5-6.5 ft bgs**	
5							Duluth Complex gabbro.		5
10									10
15							End of Boring - 18 feet		15

Barr Engineering Co

BARR Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF WELL MW-05-08

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/16/05 Ended 3/16/05
Elevation --
Location NorthMet Mine Site
Logged By Jere Mohr
Total Depth 28.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION
0				Wet @ 6"	SM		Light brown medium to coarse silty sand.
5							Dark brown, well-sorted medium sand.
				Wet	SP		
10							
				Wet	SP		Dark brown, well-sorted fine to medium sand.
							Grayish brown well-sorted fine to medium sand with silt.
15				Wet	SP		
							Gray silty clay with granite and mafic rock fragments and pebbles. (Till)
20				Wet			
					CL		
25				Wet			
							End of Boring - 28.5 feet

WELL OR PIEZOMETER CONSTRUCTION DETAIL

PRO. CASING
Diameter: **6 inches**
Type: **Steel**
Interval: **0-5 ft bgs**

RISER CASING
Diameter: **2 inches**
Type: **PVC**
Interval: **0-7.5 ft bgs**

GROUT
Type: **Cement**
Interval: **0-5 ft bgs**

SEAL
Type: **Bentonite**
Interval: **5-7 ft bgs**

SANDPACK
Type: **Red Flint**
Interval: **7-17 ft bgs**

SCREEN
Diameter: **2 inches**
Type: **PVC**
Interval: **7.5-17.5 ft bgs**

Natural formation allowed to cave below 17.5' bgs.

DEPTH FEET: 0, 5, 10, 15, 20, 25

Barr Engineering Co

BARR Telephone:
Fax:

Remarks Well installed in adjacent boring (boring not logged) due to loss of casing in MW-05-08. Heaving sand - difficult drilling and well installation.

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF WELL MW-05-09

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/10/05 Ended 3/11/05
Elevation --
Location NorthMet Mine Site
Logged By Mark Hagley
Total Depth 13.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION
0							Topsoil.
					SP		Brown, fine-grained sand with 5-10% gravel, moist.
				Dry	SM		Gray-brown, fine-grained silty sand with up to 40% gravel, cobbles and boulders (angular), dry. Very difficult drilling (highly compacted).
5				Wet	SP		Brown, medium to coarse sand, uniform, wet.
				Moist/Wet	SM		Brown silty sand with some clay and trace of gravel and cobbles, moist/wet.
10							Gray-black, fine grained crystalline rock, magnetic (Iron formation) assumed to be a boulder.
							End of Boring - 13 feet
15							

WELL OR PIEZOMETER CONSTRUCTION DETAIL

PRO. CASING
Diameter: **6 inches**
Type: **Steel**
Interval: **0-4.5 ft bgs**

RISER CASING
Diameter: **2 inches**
Type: **PVC**
Interval: **0-7.5 ft bgs**

GROUT
Type: **Cement**
Interval: **0-4.5 ft bgs**

SEAL
Type: **Bentonite**
Interval: **4.5-6.5 ft bgs**

SANDPACK
Type: **Red Flint**
Interval: **6.5-13 ft bgs**

SCREEN
Diameter: **2 inches**
Type: **PVC**
Interval: **7.5-12.5 ft bgs**

DEPTH FEET: 5, 10, 15

Barr Engineering Co

BARR Telephone:
Fax:

Remarks

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF Boring SB-05-01

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/13/05 Ended 3/13/05
Elevation --
Location NorthMet Mine Site
Logged By Jere Mohr
Total Depth 19.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				Wet	CL		Light brown to gray clayey topsoil with rocks (~25%), wet at 1' bgs.	
				Wet	CL		Grayish-brown silty clay, wet.	
5					OL		Reddish-brown organic-rich silty clay.	5
							Dark brown to gray organic-rich silty clay. Rocky at ~10'. Rock is fine-grained black (Virginia Formation).	
10				Wet	OL			10
15							Black fine-grained rock (Virginia Formation).	15
				Wet				
							End of Boring - 19 feet	

Barr Engineering Co

Telephone:
Fax:

Remarks Temp well screen (5') set from 10-15' bgs. Allowed to collapse to ~8' bgs, then bentonite chips.

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF BORING SB-05-03

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/15/05 Ended 3/15/05
Elevation --
Location NorthMet Mine Site
Logged By Jere Mohr
Total Depth 20.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				Moist	CL		Reddish-brown sandy clay with cobbles.	
5				Wet	CL		Dark brown to gray sandy clay.	5
				Moist	CL		Reddish brown sandy clay with ~30% rocks/cobbles (Virginia Formation).	
10				Wet	SM		Gray-brown silty sand.	10
				Moist	CL		Gray sandy clay with ~20% rocks/pebbles.	
							Boulder (no recovery).	
15					CL		Very dense gray clay.	15
							Fine grained black rock (Virginia Formation).	
20							End of Boring - 20.5 feet	20

Barr Engineering Co
BARR
Telephone:
Fax:

Remarks Temp well screen (5') set from 7.5' to 12.5' bgs.

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring SB-05-04

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/7/05 Ended 3/8/05
Elevation --
Location NorthMet Mine Site
Logged By Mark Hagley
Total Depth 20.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
					PT		Peat/wetland vegetation, frozen.	
					ML		Tan - brown clayey silt, uniform, moist to wet.	
5								5
					CL		Dark-gray silty clay, dense.	
					ML		Dark-gray, sandy silt with ~10% cobbles (up to 2" diameter)	
10					SM		Gray silty fine sand with 10-20% coarse gravel and cobbles (<1/2" to 3+").	10
15							Greenish-black crystalline rock - Duluth Complex gabbro.	15
							End of Boring - 20 feet	

Barr Engineering Co

BARR Telephone:
Fax:

Remarks Temp well screen (5') set from ~15-20' bgs, allowed to collapse from 14-20', bentonite chips from 2-14' bgs.

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF Boring SB-05-05

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/13/05 Ended 3/13/05
Elevation --
Location NorthMet Mine Site
Logged By Jere Mohr
Total Depth 18.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				Moist	CL		Dark brown to black clayey topsoil.	
							Dark black fine-grained rock (boulder).	
5								5
				Dry	SM		Medium brown silty sand.	
							Dark black fine-grained rock.	
10								10
				Dry				
15								15
							End of Boring - 18 feet	

Barr Engineering Co

Telephone:
Fax:

Remarks No temp well set - dry borehole.

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF Boring SB-05-06

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/14/05 Ended 3/14/05
Elevation --
Location NorthMet Mine Site
Logged By Jere Mohr
Total Depth 16.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
					OL		Organic rich dark brown clay. Frozen to 4'.	
				Wet	OL		Very loose organic rich clay.	
5							Boulder - minimal recovery. Granite recovered from ~9' bgs.	5
10				Wet	SM		Light brown silty coarse sand with pebbles.	10
				Wet	CL		Light brown silty clay with ~25% pebbles.	
15							Black fine-grained rock.	15
							End of Boring - 16 feet	

Barr Engineering Co

BARR Telephone:
Fax:

Remarks Temp well screen (5') set from 11.5 to 15.5'.

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF Boring SB-05-07

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/12/05 Ended 3/12/05
Elevation --
Location NorthMet Mine Site
Logged By Mark Hagley
Total Depth 17.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
				Moist	SM		Brown silty sand with 10-20% cobbles and boulders (up to 4" diameter). Frost to 1.5', moist below.	
5					SM		Gray/brown silty sand with trace of clay and 10-20% cobbles (<1/2" to 4").	5
10					ML		Dark gray sandy silt with cobbles.	10
					SC		Very dense brown clayey sand with ~15% gravel and cobbles (to 1"). (Till)	
15							Green/black coarse crystalline rock (Duluth Complex gabbro).	15
							End of Boring - 17 feet	

Barr Engineering Co
Telephone:
Fax:

Remarks Temp well screen (5') set from 8-13' bgs, allowed to collapse up to 6.2', then bentonite chips above.

Additional data may have been collected in the field which is not included on this log.

LOG OF Boring SB-05-10

SHEET 1 OF 1

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/9/05 Ended 3/10/05
Elevation --
Location NorthMet Mine Site
Logged By Mark Hagley
Total Depth 14.5

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
					PT		Peat/Organic material. Frozen.	
					SM		Fine-grained silty sand, brown, with 5-10% gravel and cobbles (up to 1/2", angular).	
5							Dark gray, fine-grained crystalline rock. Argillite (Virginia Formation).	5
10								10
15							End of Boring - 14.5 feet	15

Barr Engineering Co

BARR

Telephone:
Fax:

Remarks No temporary well set in boring; set in adjacent boring SB-05-10A

Additional data may have been collected in the field which is not included on this log.

ENVIRO LOG 5 (5/27/04) 2369862.GPJ BARRLOG.GDT 1/17/06

LOG OF WELL SB-05-10A

Client PolyMet Mining Corporation
Drill Contractor WDC Exploration & Wells
Project Name PolyMet Hydrogeologic Investigation
Drill Method Rotasonic
Number 23/69-862
Drilling Started 3/10/05 Ended 3/10/05
Elevation --
Location NorthMet Mine Site
Logged By Mark Hagley
Total Depth 6.0

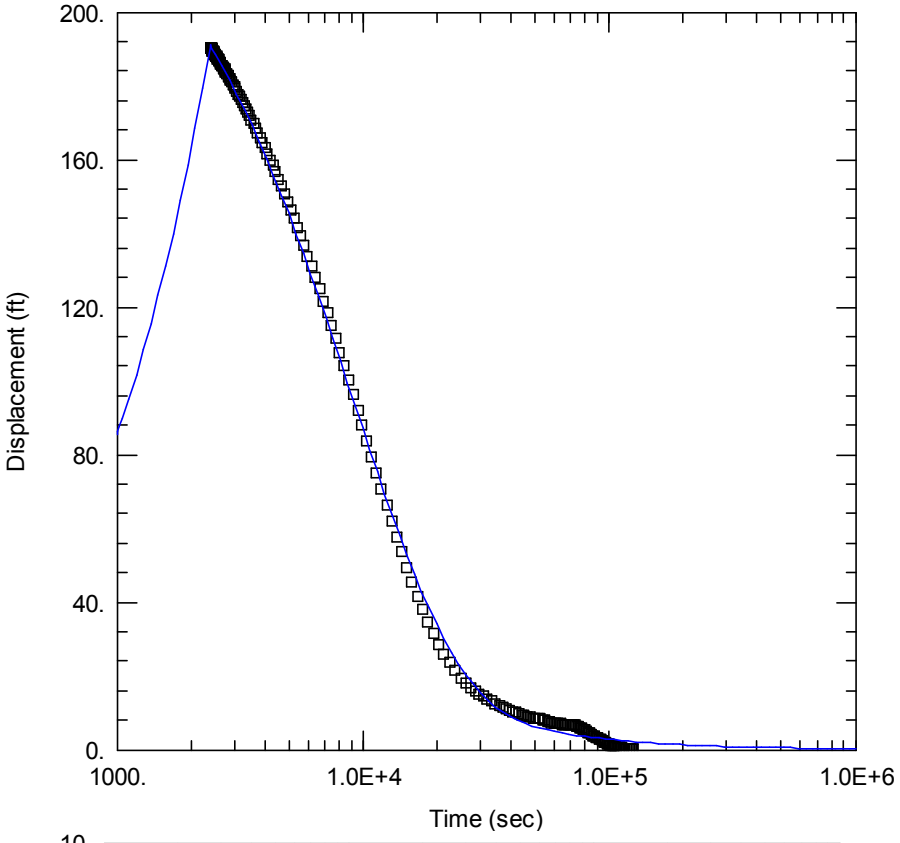
DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Discoloration-Odor-Sheen	Moisture	ASTM	LITHOLOGY	DESCRIPTION	DEPTH FEET
					PT		Peat/Organic material. Frozen.	
					SM		Fine-grained silty sand, brown, with 5-10% gravel and cobbles (up to 1/2", angular).	
5					CL		Dark brown sandy clay with <5% angular gravel and cobbles (<1/2").	5
							End of Boring - 6 feet	
10								10
15								15

Barr Engineering Co
Telephone:
Fax:

Remarks Temp well screen (4') set from 2-6' bgs, allowed to collapse to ~1.5' bgs, then bentonite chips to surface.

Additional data may have been collected in the field which is not included on this log.

Appendix B

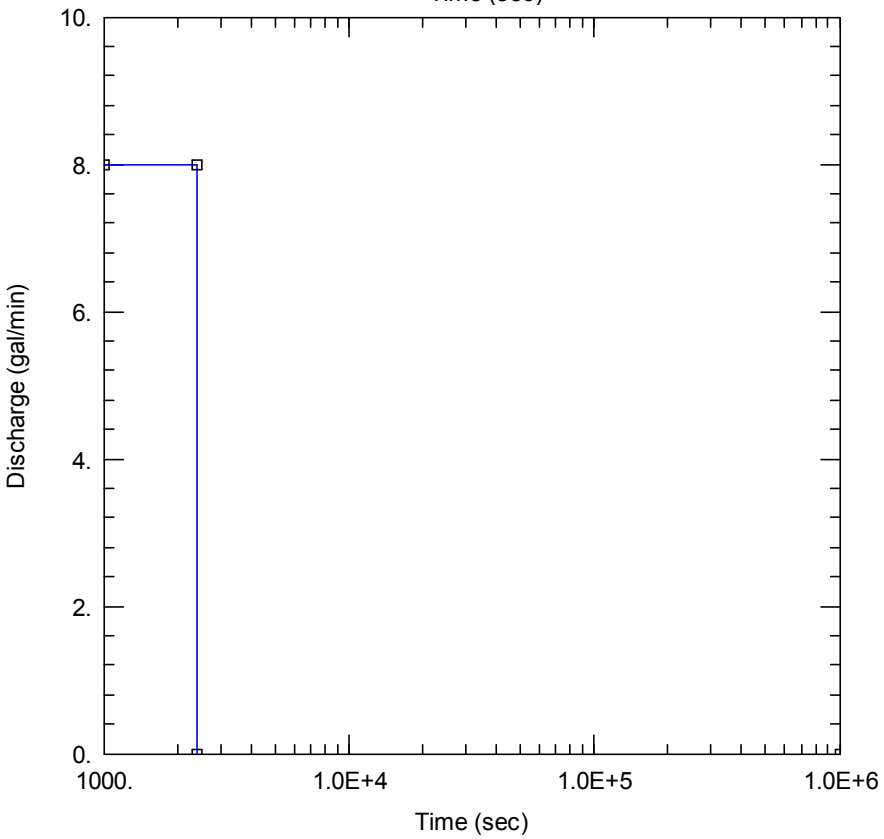


Obs. Wells
□ 05-401M

Aquifer Model
Fractured

Solution
Moench w/slab blocks

Parameters
K = 0.0036 ft/day
Ss = 2.912E-13 ft^{-1}
K' = 0.000804 ft/day
Ss' = 3.624E-6 ft^{-1}
Sw = 0.02649
Sf = 2.321

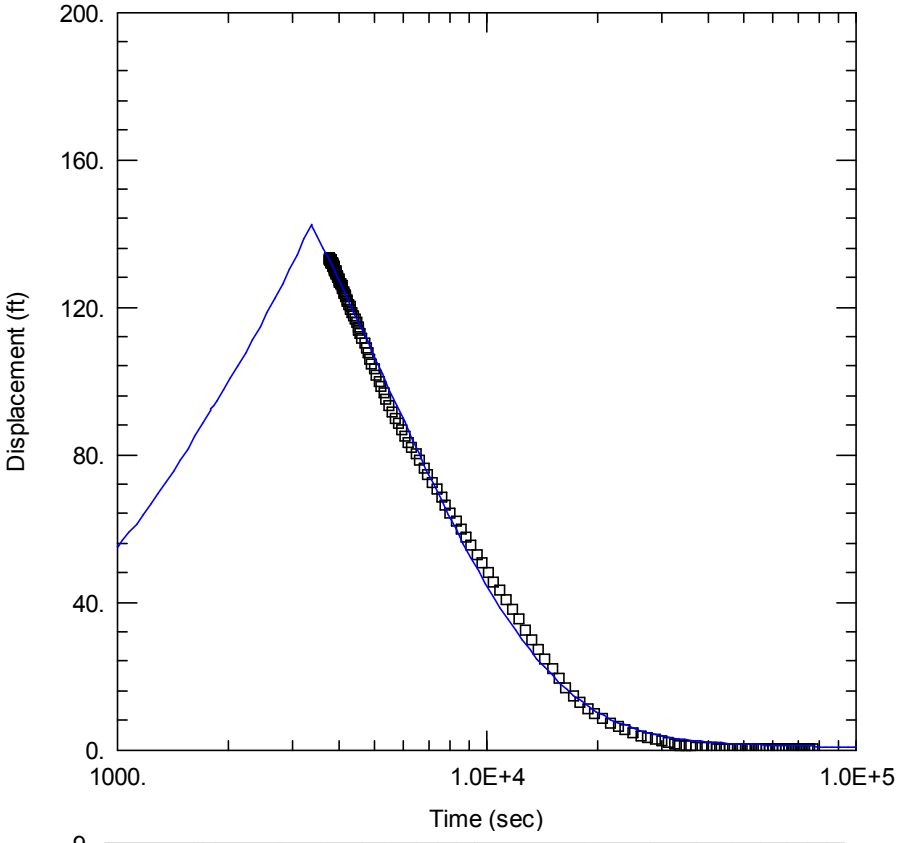


Pumping Wells
□ 05-401M

Aquifer Model
Fractured

Solution
Moench w/slab blocks

Parameters
K = 0.0036 ft/day
Ss = 2.912E-13 ft^{-1}
K' = 0.000804 ft/day
Ss' = 3.624E-6 ft^{-1}
Sw = 0.02649
Sf = 2.321

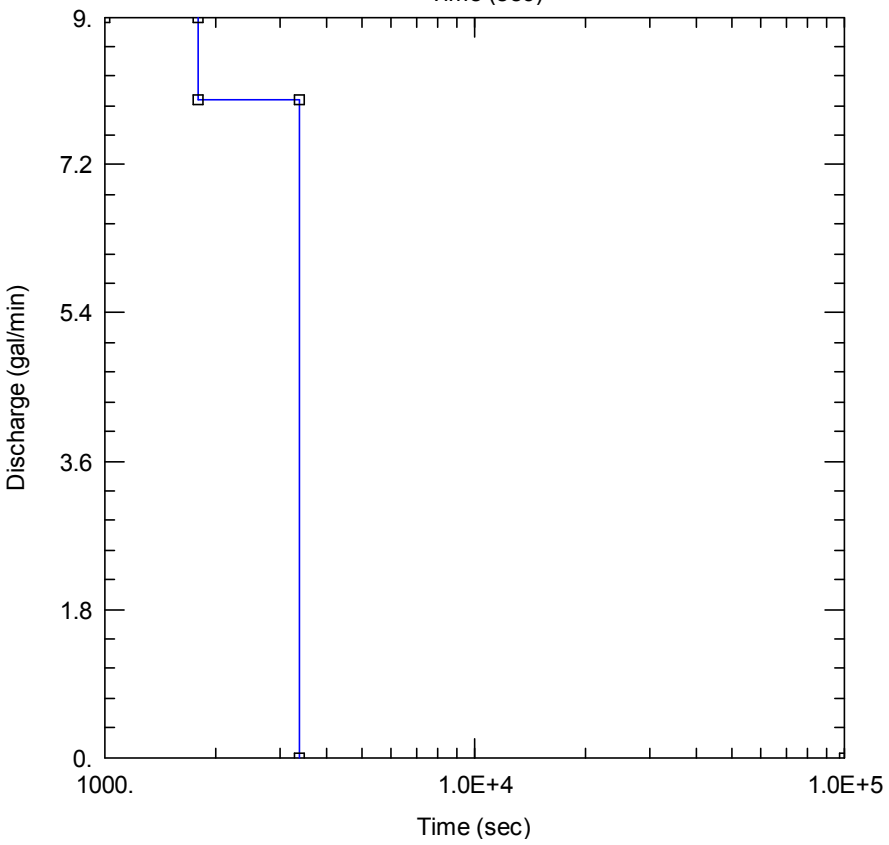


Obs. Wells
□ 05-404M

Aquifer Model
Fractured

Solution
Moench w/slab blocks

Parameters
K = 0.01034 ft/day
Ss = 4.025E-13 ft^{-1}
K' = 8.64E-6 ft/day
Ss' = 0.0005552 ft^{-1}
Sw = 2.727
Sf = 0.002511

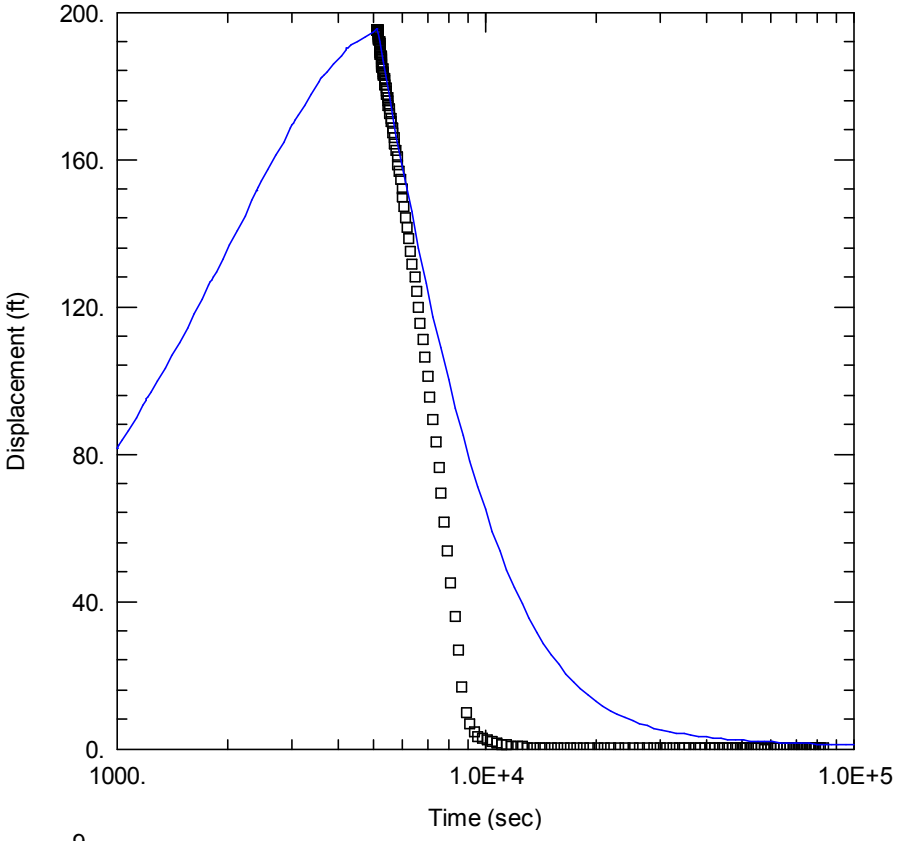


Pumping Wells
□ 05-404M

Aquifer Model
Fractured

Solution
Moench w/slab blocks

Parameters
K = 0.01034 ft/day
Ss = 4.025E-13 ft^{-1}
K' = 8.64E-6 ft/day
Ss' = 0.0005552 ft^{-1}
Sw = 2.727
Sf = 0.002511

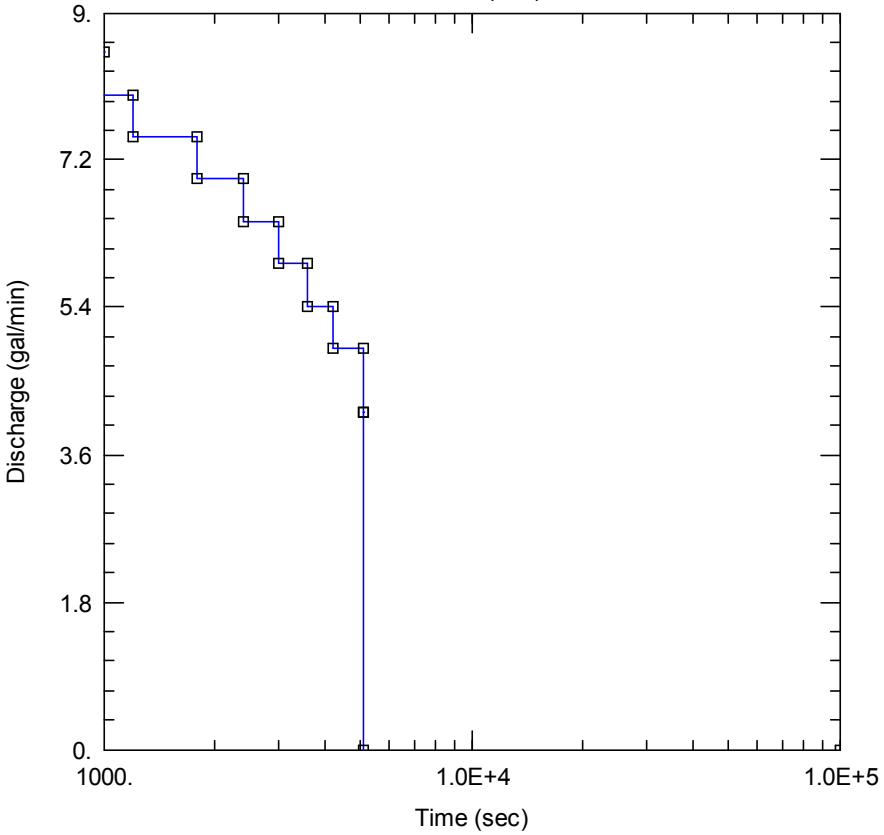


Obs. Wells
□ 05-407M

Aquifer Model
Fractured

Solution
Moench w/slab blocks

Parameters
K = 0.008411 ft/day
Ss = 1.0E-9 ft^{-1}
K' = 6.813E-7 ft/day
Ss' = 0.002581 ft^{-1}
Sw = 0.
Sf = 0.

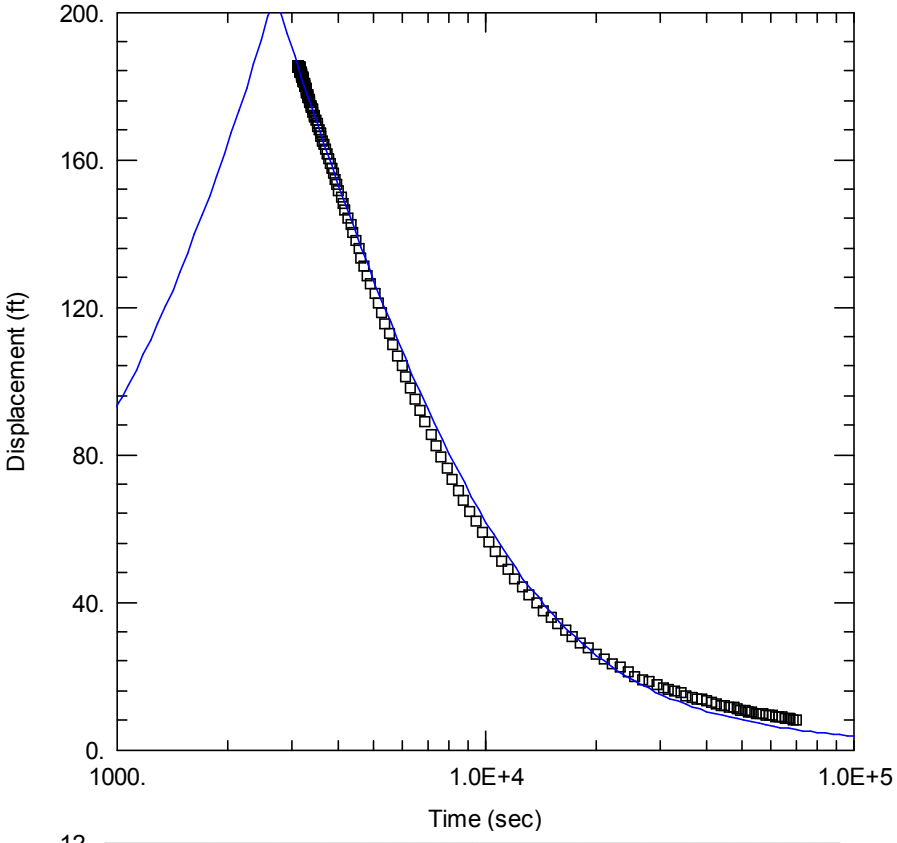


Pumping Wells
□ 05-407M

Aquifer Model
Fractured

Solution
Moench w/slab blocks

Parameters
K = 0.008411 ft/day
Ss = 1.0E-9 ft^{-1}
K' = 6.813E-7 ft/day
Ss' = 0.002581 ft^{-1}
Sw = 0.
Sf = 0.

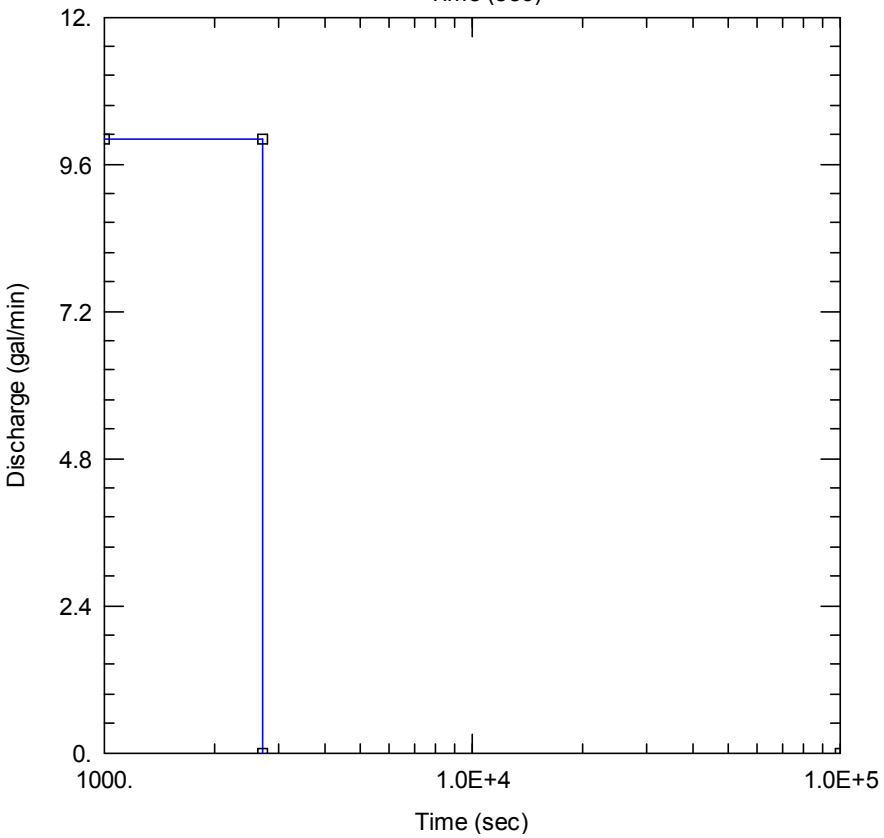


Obs. Wells
□ 05-411M

Aquifer Model
Fractured

Solution
Moench w/slab blocks

Parameters
K = 0.0008388 ft/day
Ss = 6.499E-5 ft^{-1}
K' = 0.0001 ft/day
Ss' = 1. ft^{-1}
Sw = 0.
Sf = 0.

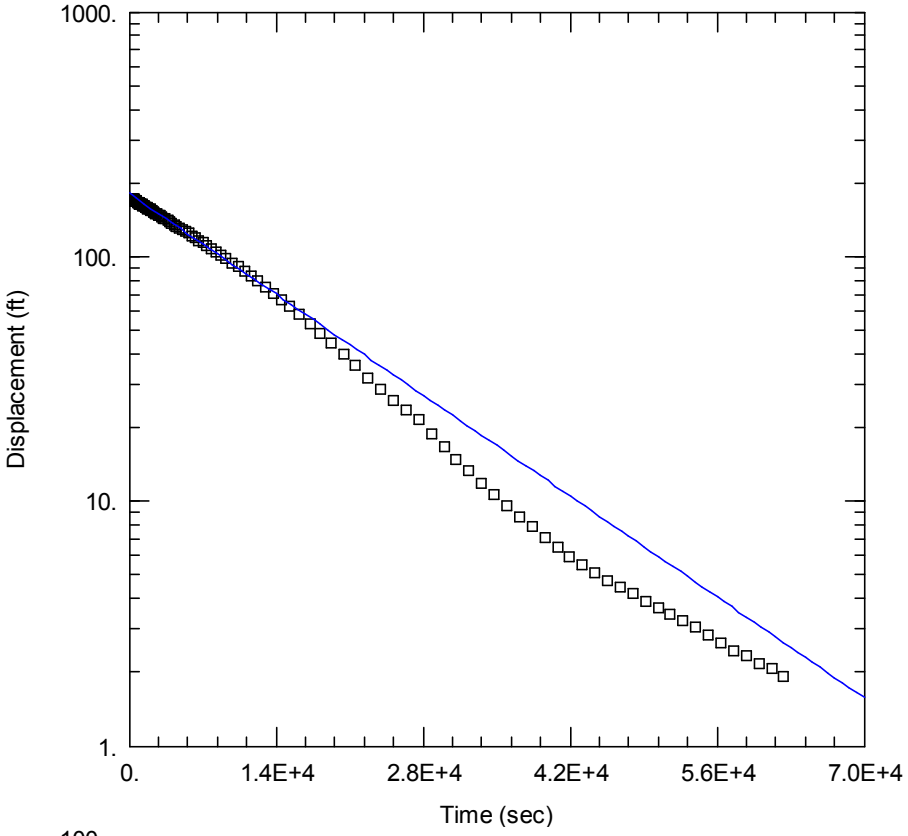


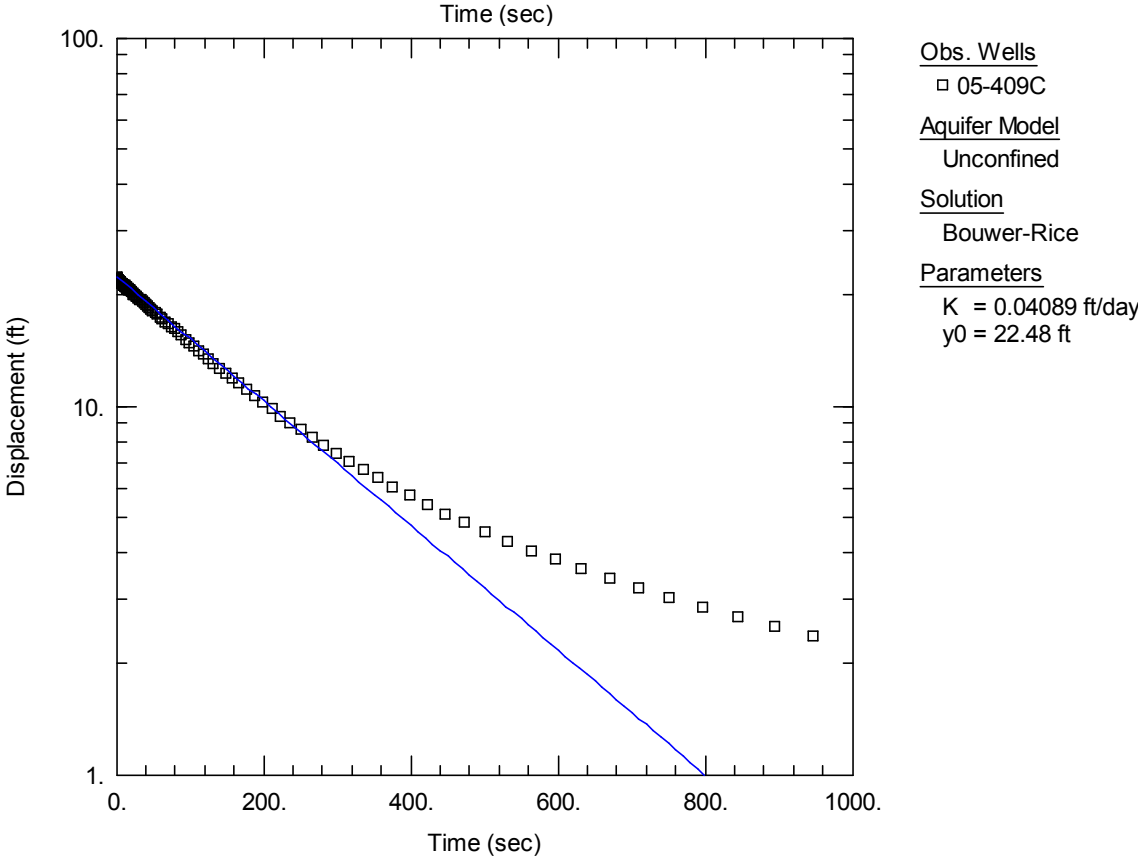
Pumping Wells
□ 05-411M

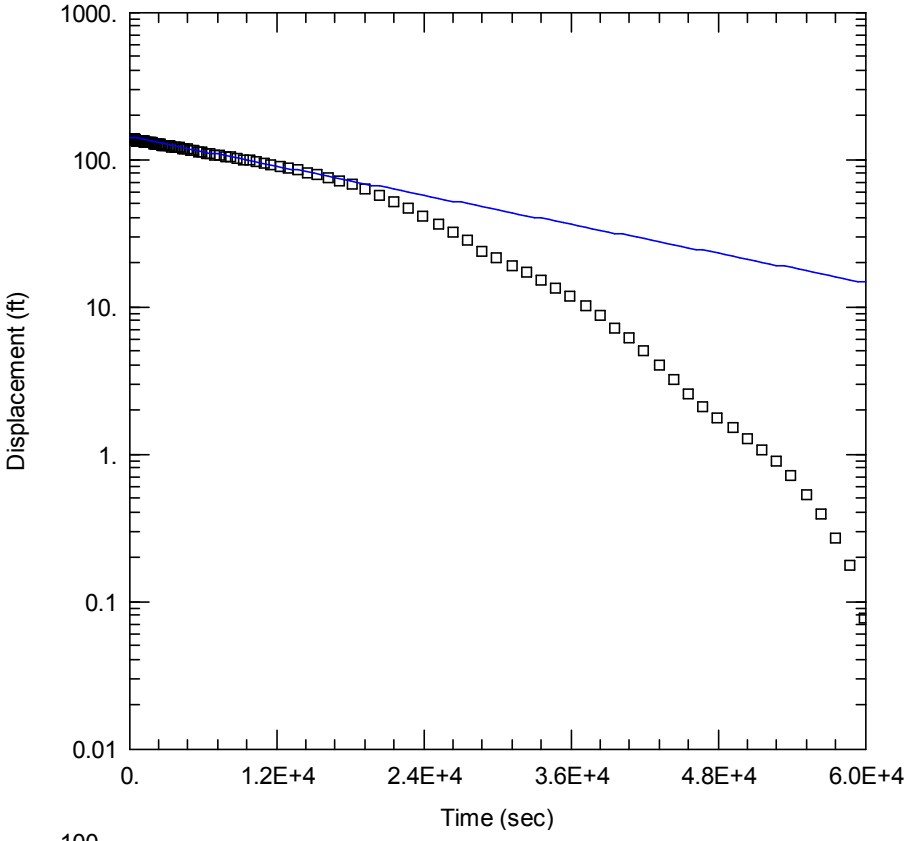
Aquifer Model
Fractured

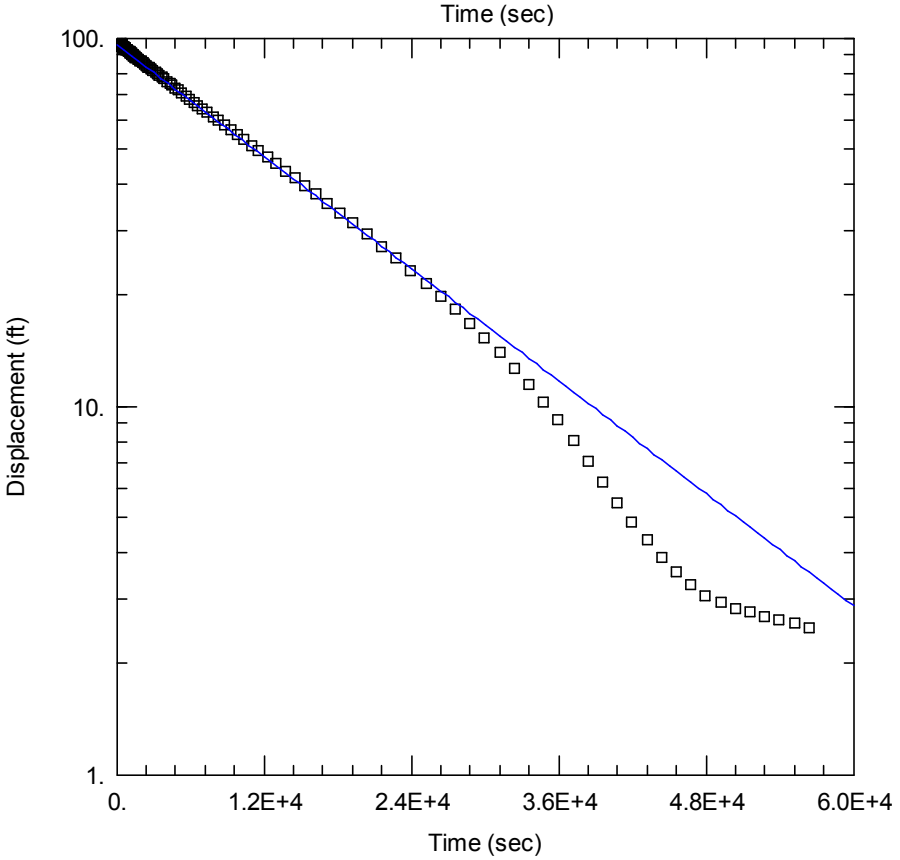
Solution
Moench w/slab blocks

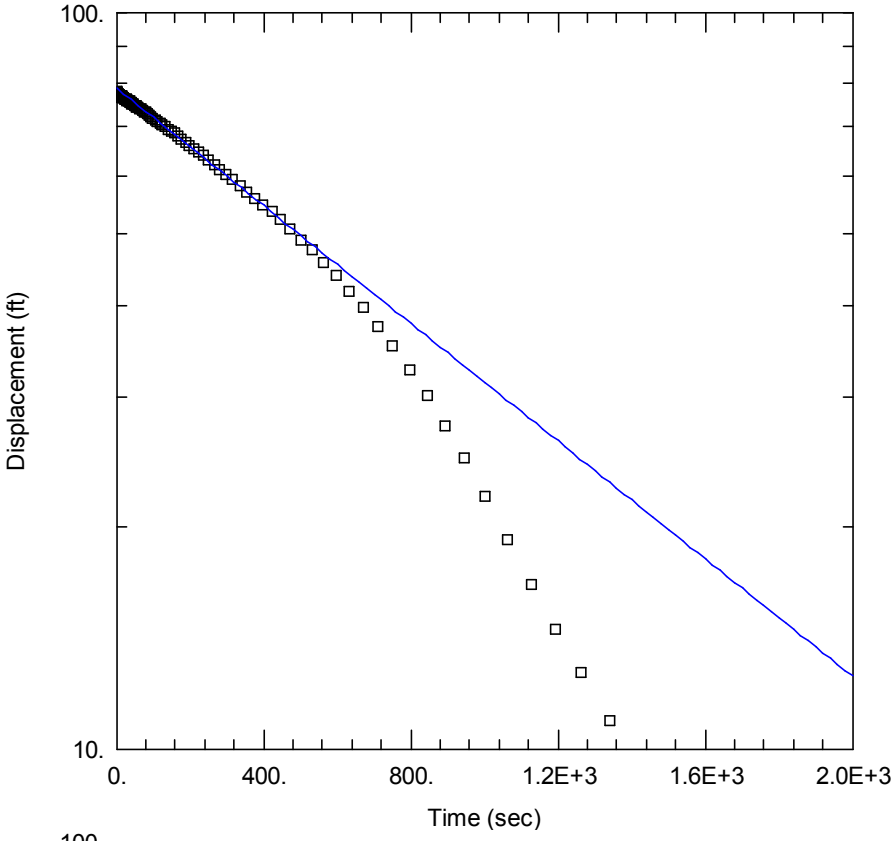
Parameters
K = 0.0008388 ft/day
Ss = 6.499E-5 ft^{-1}
K' = 0.0001 ft/day
Ss' = 1. ft^{-1}
Sw = 0.
Sf = 0.

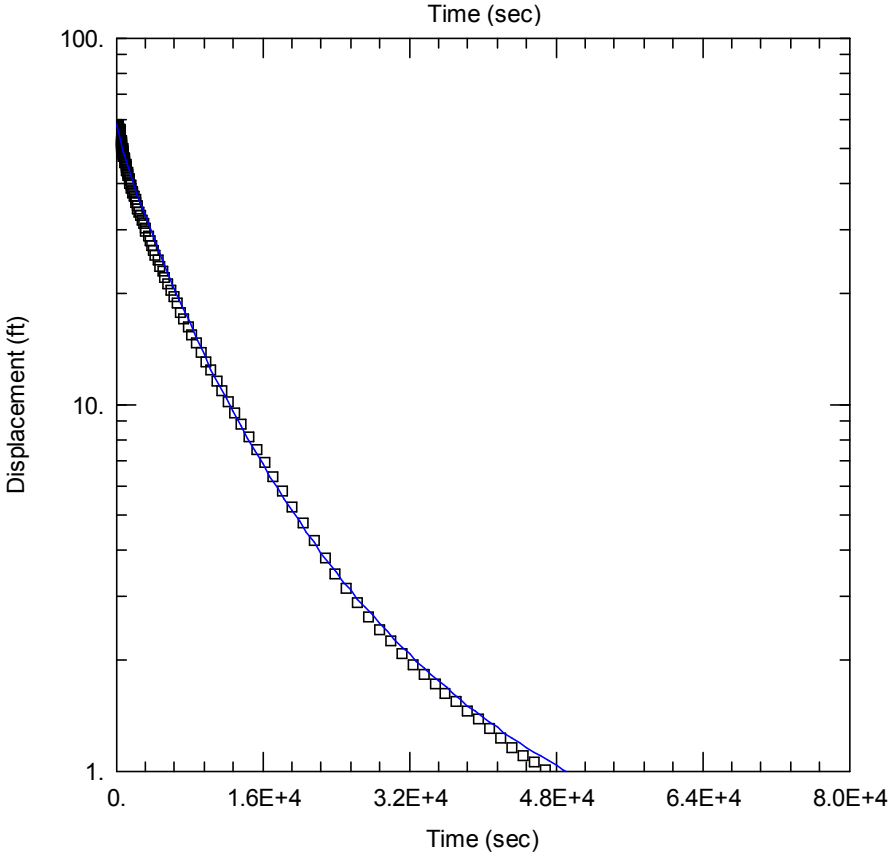

1000.
100.
10.
1.
Displacement (ft)
0.
1.4E+4
2.8E+4
4.2E+4
5.6E+4
7.0E+4
Time (sec)
Obs. Wells
05-405C
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.0006725 ft/day
y0 = 181.1 ft

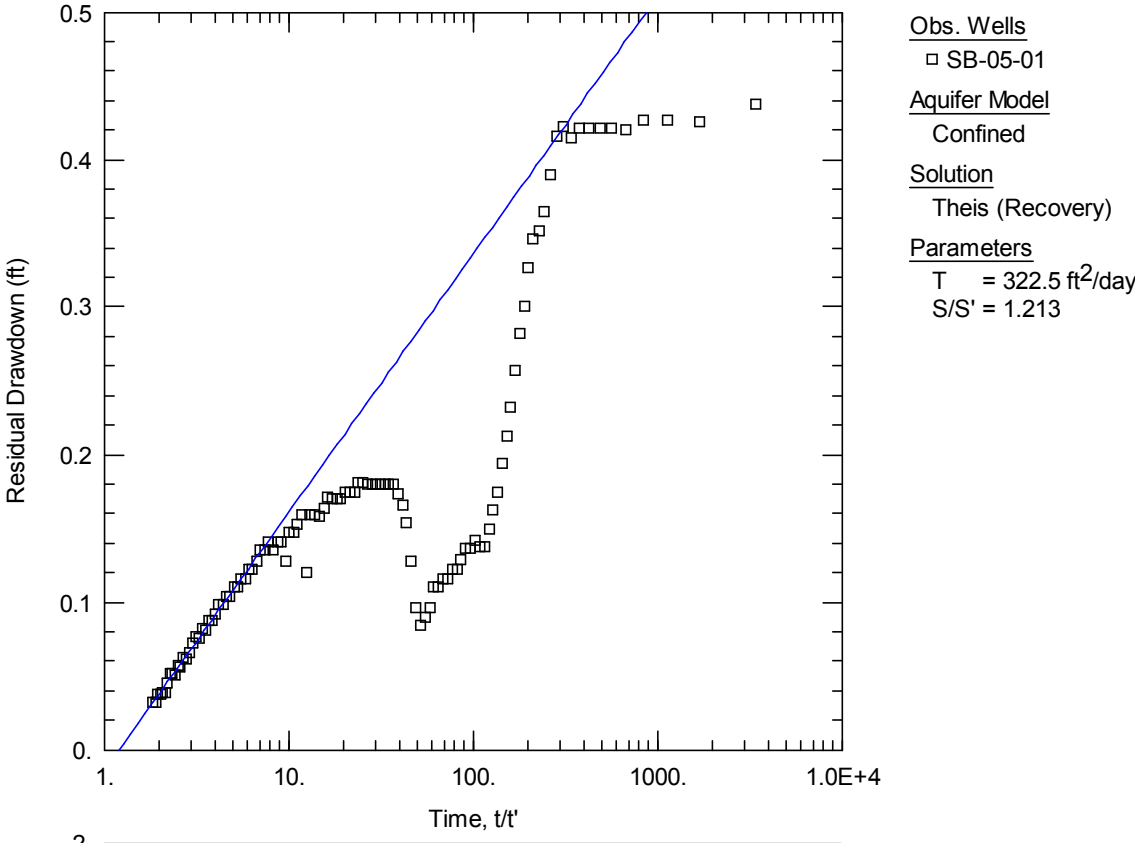

100.
10.
1.
Displacement (ft)
0.
200.
400.
600.
800.
1000.
Time (sec)
Obs. Wells
05-409C
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.04089 ft/day
y0 = 22.48 ft

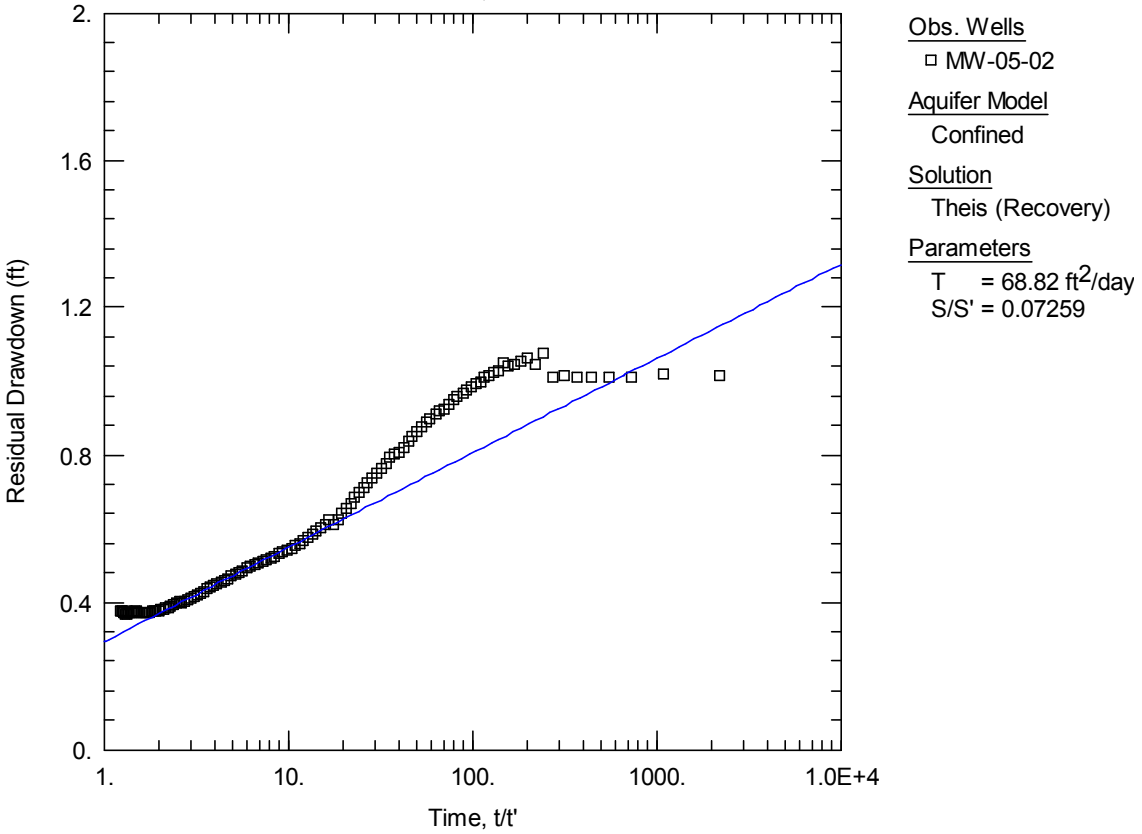

1000.
100.
10.
1.
0.1
0.01
Displacement (ft)
0.
1.2E+4
2.4E+4
3.6E+4
4.8E+4
6.0E+4
Time (sec)
Obs. Wells
05-406C
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.0002645 ft/day
y0 = 141.7 ft

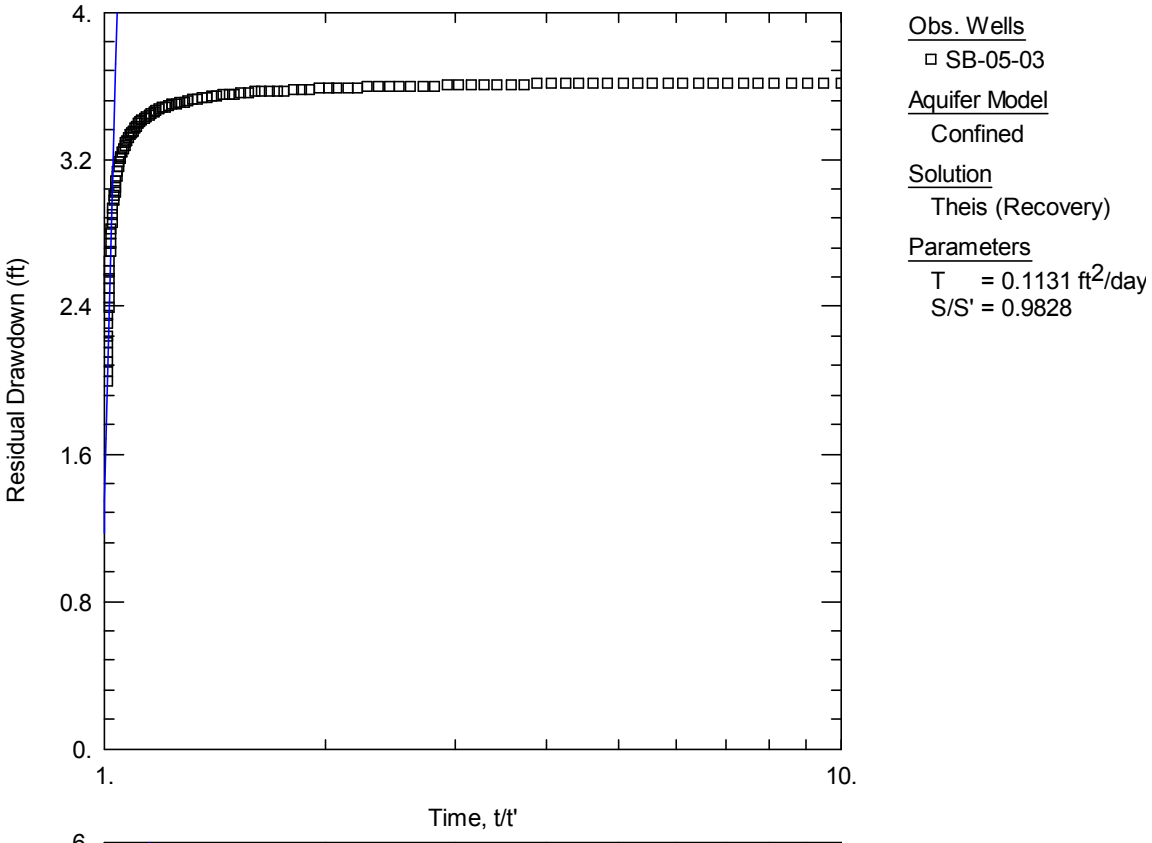

100.
10.
1.
Displacement (ft)
0.
1.2E+4
2.4E+4
3.6E+4
4.8E+4
6.0E+4
Time (sec)
Obs. Wells
05-410
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.0004185 ft/day
y0 = 96.05 ft

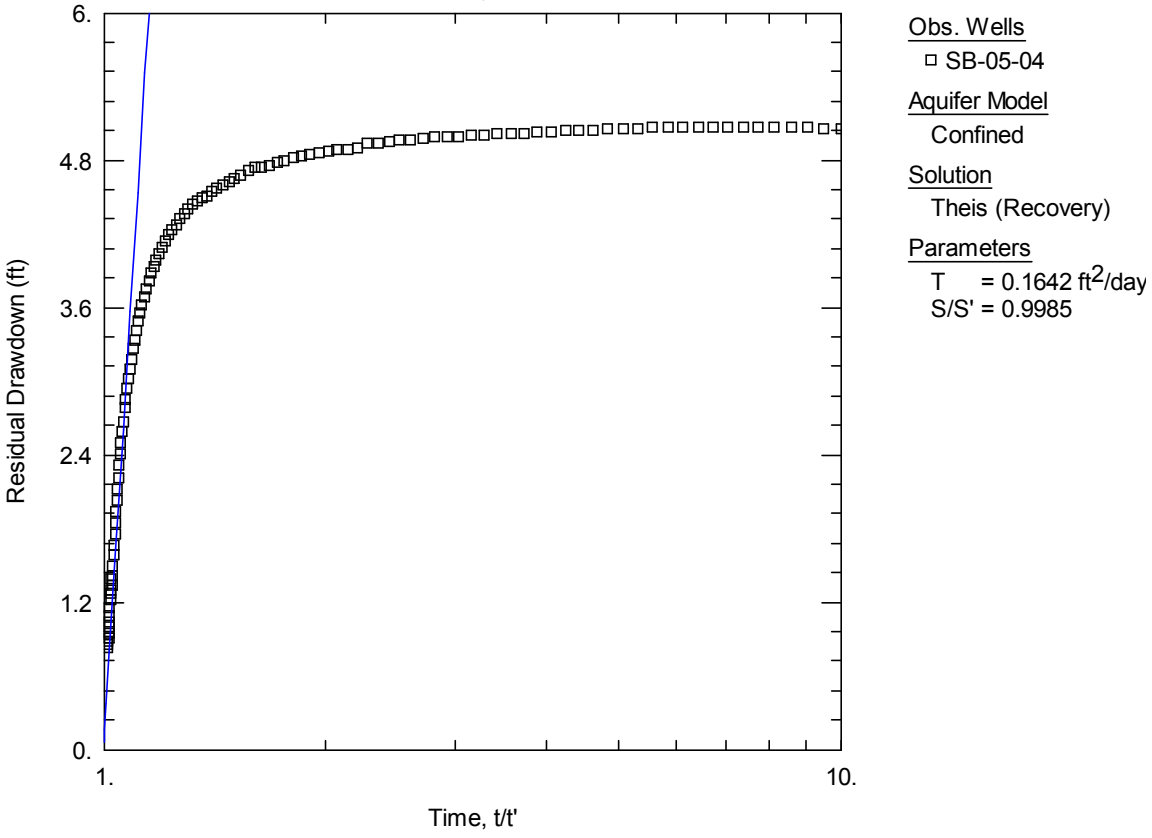

100.
10.
Displacement (ft)
0.
400.
800.
1.2E+3
1.6E+3
2.0E+3
Time (sec)
Obs. Wells
05-413C
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 0.01175 ft/day
y0 = 78.84 ft

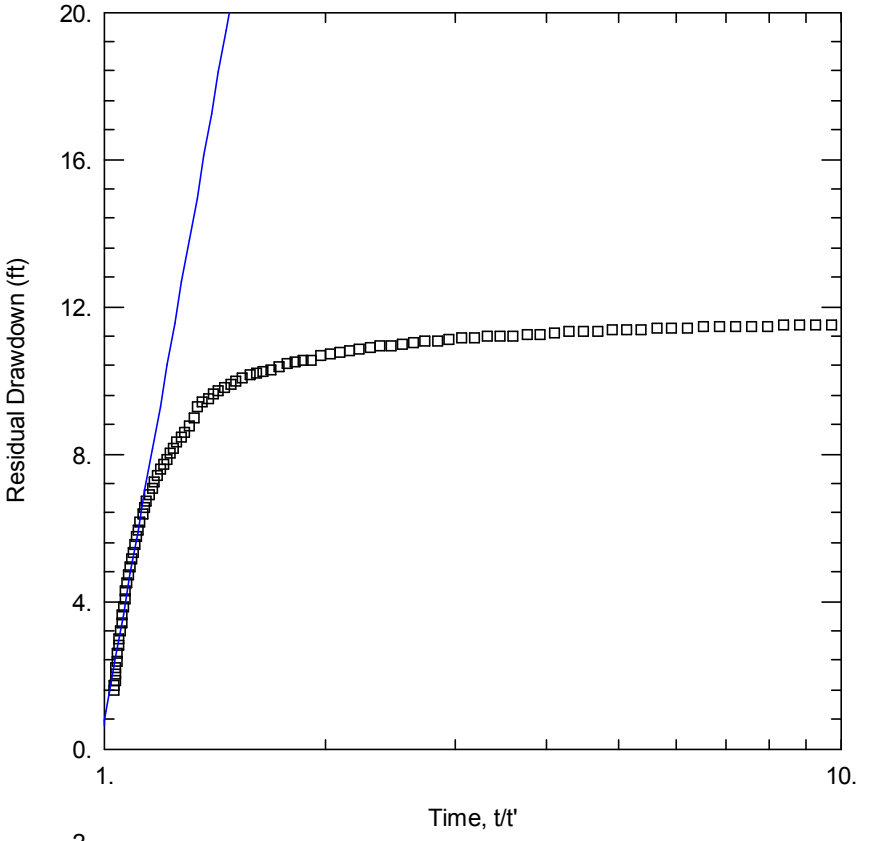

100.
10.
1.
Displacement (ft)
0.
1.6E+4
3.2E+4
4.8E+4
6.4E+4
8.0E+4
Time (sec)
Obs. Wells
05-414C
Aquifer Model
Unconfined
Solution
KGS Model w/skin
Parameters
Kr = 0.00039 ft/day
Ss = 1.111E-7 ft-1
Kz/Kr = 1.
Kr' = 0.00039 ft/day
Ss' = 1.111E-7 ft-1
Kz/Kr' = 1.


Residual Drawdown (ft)
0.5
0.4
0.3
0.2
0.1
0.
1.
10.
100.
1000.
1.0E+4
Time, t/t'
Obs. Wells
SB-05-01
Aquifer Model
Confined
Solution
Theis (Recovery)
Parameters
T = 322.5 ft2/day
S/S' = 1.213


Residual Drawdown (ft)
2.
1.6
1.2
0.8
0.4
0.
1.
10.
100.
1000.
1.0E+4
Time, t/t'
Obs. Wells
MW-05-02
Aquifer Model
Confined
Solution
Theis (Recovery)
Parameters
T = 68.82 ft2/day
S/S' = 0.07259


4.
3.2
2.4
1.6
0.8
0.
Residual Drawdown (ft)
1.
10.
Time, t/t'
Obs. Wells
SB-05-03
Aquifer Model
Confined
Solution
Theis (Recovery)
Parameters
T = 0.1131 ft2/day
S/S' = 0.9828


6.
4.8
3.6
2.4
1.2
0.
Residual Drawdown (ft)
1.
10.
Time, t/t'
Obs. Wells
SB-05-04
Aquifer Model
Confined
Solution
Theis (Recovery)
Parameters
T = 0.1642 ft2/day
S/S' = 0.9985

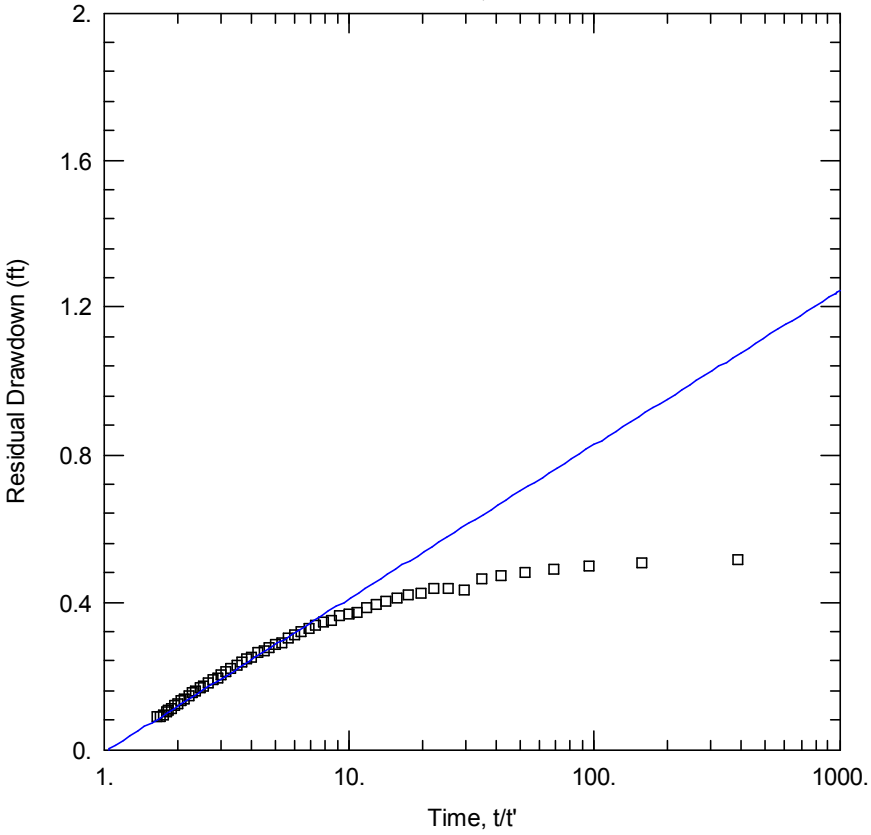


Obs. Wells
□ SB-05-06

Aquifer Model
Confined

Solution
Theis (Recovery)

Parameters
T = 0.1556 ft^2/day
S/S' = 0.9871

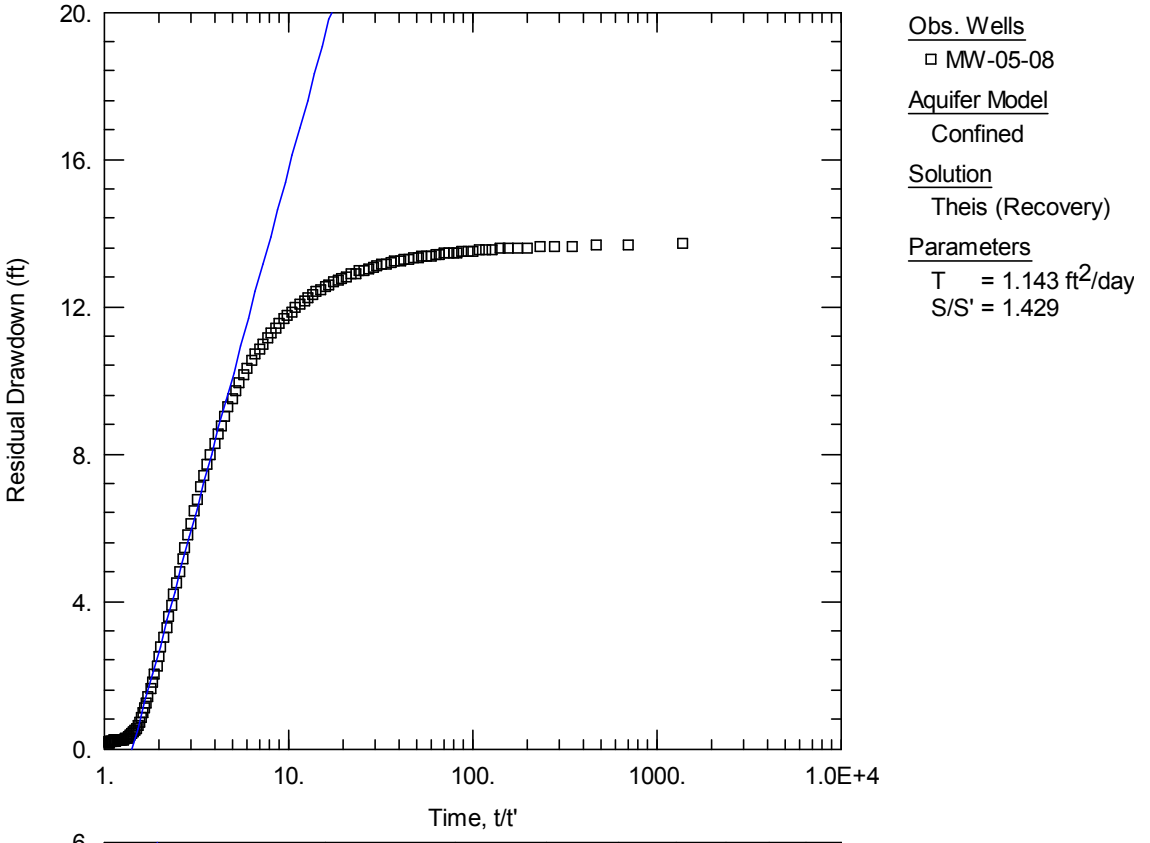


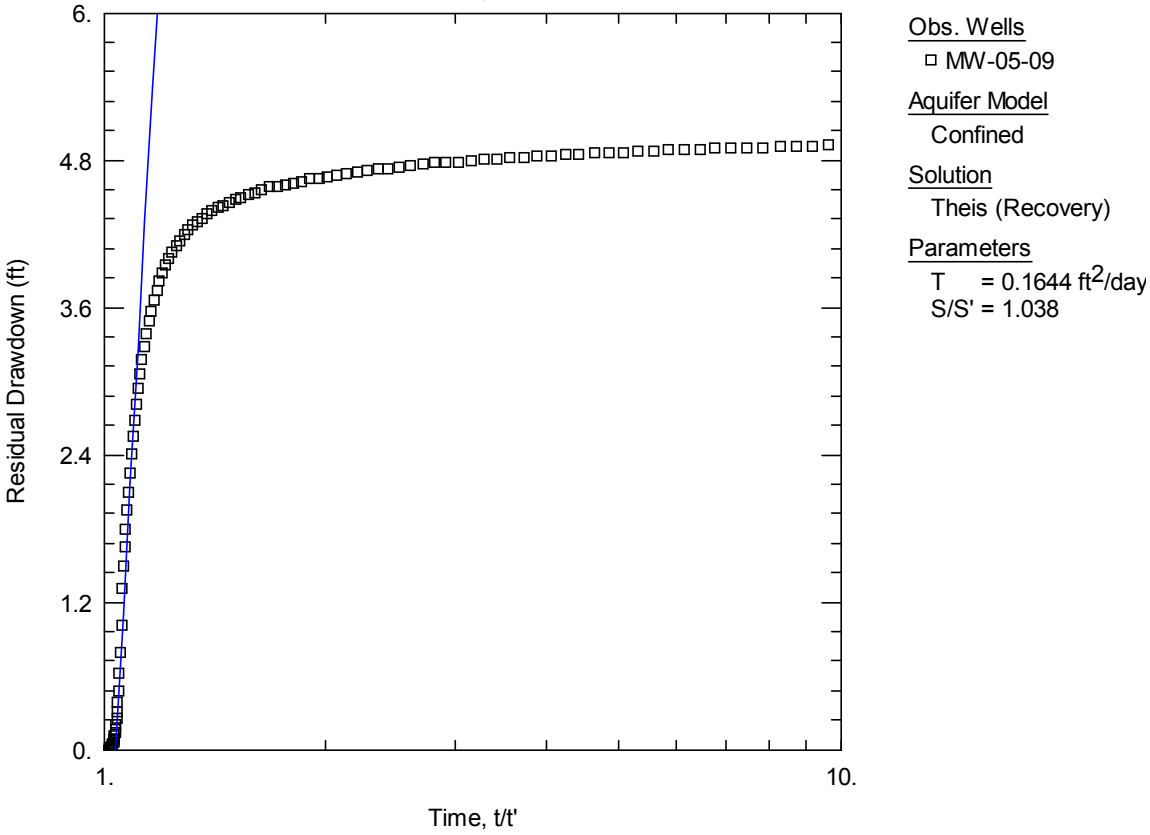
Obs. Wells
□ SB-05-07

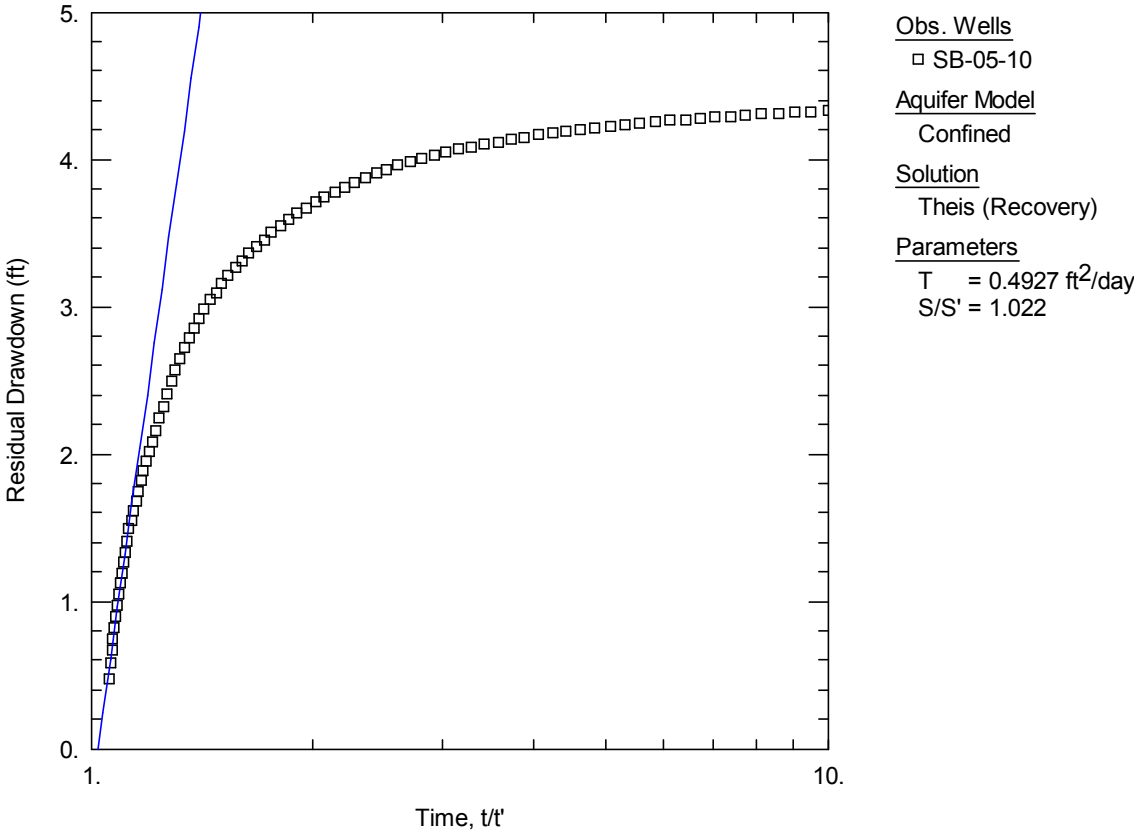
Aquifer Model
Confined

Solution
Theis (Recovery)

Parameters
T = 42.2 ft^2/day
S/S' = 1.052


20.
16.
12.
8.
4.
0.
Residual Drawdown (ft)
1.
10.
100.
1000.
1.0E+4
Time, t/t'
Obs. Wells
MW-05-08
Aquifer Model
Confined
Solution
Theis (Recovery)
Parameters
T = 1.143 ft2/day
S/S' = 1.429


6.
4.8
3.6
2.4
1.2
0.
Residual Drawdown (ft)
1.
10.
Time, t/t'
Obs. Wells
MW-05-09
Aquifer Model
Confined
Solution
Theis (Recovery)
Parameters
T = 0.1644 ft2/day
S/S' = 1.038


5.
4.
3.
2.
1.
0.
Residual Drawdown (ft)
1.
10.
Time, t/t'
Obs. Wells
SB-05-10
Aquifer Model
Confined
Solution
Theis (Recovery)
Parameters
T = 0.4927 ft2/day
S/S' = 1.022

Appendix C

Appendix C
Field Sampling Data Sheets

NOTE:
At the time of sample collection, the names of the exploratory boreholes were unknown and temporary names were given to the samples collected from these boreholes. The table below shows the temporary borehole names and the actual borehole names. The temporary names are used in this appendix, while the actual borehole names are used throughout the report.

Actual Borehole Name	Temporary Borehole Name
05-407M	26100
05-401M	East

Barr Engineering Company
Field Log Data Sheet

Client: PolyMet Mining Corp.	**Monitoring Point:** 26100
Location: NorthMet	**Date:** 3/10/05
Project #: 23/69-862-004-005	**Sample Time:** 9:15

GENERAL DATA		STABILIZATION TEST						
Barr lock:	No			mS/cm³		ORP		
Casing diameter:	6"	Time/ Volume	Temp. °C	Cond. @ 25	pH	Eh	D.O.	Turbidity Appearance
Total well depth:*	350'	40 min/ 400 gal	5.37	0.208	8.25	75.3	✓	SL. Cloudy
Static water level:*	5.32'	43 min/ 430 gal	5.63	0.208	8.09	93.4	✓	↓
Water depth:*	344.68'	45 min/ 450 gal	5.75	0.208	8.14	98.8	✓	↓
Well volume: (gal)	506.3	47 min/ 470 gal	5.77	0.208	8.14	102.3	✓	↓
Purge method:	Submersible Pump	49 min/ 490 gal	5.80	0.207	8.15	103.5	✓	↓
Sample method:	Submersible Pump							
Start time:	8:10	Odor: None						
Stop time:	8:59	Purge Appearance: SL. cloudy						
Duration: (minutes)	49	Sample Appearance: SL. cloudy						
Rate, gpm:	10	Comments:						
Volume, purged:	490 gal							
Duplicate collected?	N							
Sample collection by: JAM 2		CO2-	Mn2-	Fe(T)-	Fe2-			
Others present: Bill, Dan (WDC)		Well Condition:						

MW: groundwater monitoring well WS: water supply well SW: surface water SE: sediment other: Open Borehole

VOC- semi-volatile- general- 2 nutrient- 2 cyanide- 1 DRO- Sulfide-

oil,grease- bacteria- total metal- 2 filtered metal- 2 methane- filter-

Others:

*Measurements are referenced from top of riser pipe, unless otherwise indicated.

Barr Engineering Company
Field Log Data Sheet

Client: PolyMet Mining Corp.	**Monitoring Point:** East
Location: NorthMet	**Date:** 3/10/05
Project #: 23/69 - 862 - 004 - 005	**Sample Time:** 11:30

GENERAL DATA		STABILIZATION TEST						
Barr lock:	No			mS/cm³		ORP		
Casing diameter:	6"	Time/ Volume	Temp. °C	Cond. @ 25	pH	~~Eh~~	D.O.	Turbidity Appearance
Total well depth:*	-	30/240	5.35	0.179	7.72	150.2	—	cloudy
Static water level:*	11.10							
Water depth:*								
Well volume: (gal)								
Purge method:	Submersible Pump							
Sample method:	Submersible Pump							
Start time:	11:00	Odor: None						
Stop time:	11:30	Purge Appearance: cloudy - drilling fluid						
Duration: (minutes)	30	Sample Appearance: " " "						
Rate, gpm:	8	Comments:						
Volume, purged:	240 gal							
Duplicate collected?	No							
Sample collection by:	JAM2	CO2-	Mn2-	Fe(T)-	Fe2-			
Others present:	Bill, Dan (WDC)	Well Condition:						

MW: groundwater monitoring well WS: water supply well SW: surface water SE: sediment other: Open Borehole

VOC- semi-volatile- general- 2 nutrient- 2 cyanide- 1 DRO- Sulfide-

oil,grease- bacteria- total metal- 2 filtered metal- 2 methane- filter-

Others:

*Measurements are referenced from top of riser pipe, unless otherwise indicated.

Barr Engineering Company
Field Log Data Sheet

Client: PolyMet Mining Corp.	**Monitoring Point:** MW-05-02
Location: NorthMet	**Date:** 3/23/05
Project #: 23/69a 862-004-005	**Sample Time:** 12:00

GENERAL DATA	
Barr lock:	Yes
Casing diameter:	2"
Total well depth:*	10.05 *
Static water level:*	7.80*
Water depth:*	2.25
Well volume: (gal)	0.37
Purge method:	Peristaltic
Sample method:	Peristaltic
Start time:	11:26
Stop time:	11:55
Duration: (minutes)	29
Rate, gpm:	0.25
Volume, purged:	7.25 gal
Duplicate collected?	No
Sample collection by:	JAM 2

STABILIZATION TEST

Time/ Volume	Temp. °C	mS/cm³ Cond. @ 25	pH	ORP Eh	D.O.	Turbidity Appearance
3 min	3.31	1.671	12.17	-66.9	✓	Clear
14 min	2.72	0.539	11.36	-18.0	✓	
17 min	2.77	0.388	11.14	-18.0	✓	
19 min	2.79	0.333	11.02	-15.3	✓	
21 min	2.83	0.273	10.79	-10.4	✓	
23 min	2.92	0.233	10.54	-2.0	✓	
25 min	2.98	0.212	10.30	4.3	✓	
27 min	2.96	0.213	10.24	7.7	✓	
29 min	2.98	0.201	10.14	11.9	✓	↓

Odor: None

Purge Appearance: Clear

Sample Appearance: Clear

Comments: Re-calibrated YSI to confirm high pH - seems OK

CO2- Mn2- Fe(T)- Fe2-

Others present: —

Well Condition: Good

MW: groundwater monitoring well WS: water supply well SW: surface water SE: sediment other:

VOC- semi-volatile- general- 2 nutrient- 2 cyanide- 1 DRO- Sulfide-

oil,grease- bacteria- total metal- 2 filtered metal- 2 methane- filter-

Others:

*Measurements are referenced from top of riser pipe, unless otherwise indicated.

Barr Engineering Company
Field Log Data Sheet

Client: PolyMet Mining Corp.	**Monitoring Point:** MW-05-08
Location: NorthMet	**Date:** 3/23/05
Project #: 23/69-862-004-005	**Sample Time:** 10:45

GENERAL DATA		STABILIZATION TEST						
Barr lock:	Yes							
Casing diameter:	2"	Time/ Volume	Temp. °C	mS/cm³ Cond. @ 25	pH	ORP ~~Eh~~	D.O.	Turbidity Appearance
Total well depth:*	20.55	2 min	4.05	0.191	8.05	12.9	✓	clear
		4 min	3.97	0.211	7.63	-116.9	✓	↓
Static water level:*	3.21	9 min	4.38	0.202	7.41	-159.9	✓	
		11 min	4.37	0.199	7.29	-191.8	✓	
Water depth:*	17.34	13 min	4.38	0.194	7.24	-205.3	✓	
		17 min	4.38	0.188	7.20	-204.2	✓	
Well volume: (gal)	2.83	19 min	4.37	0.183	7.20	-196.5	✓	
Purge method:	Peristaltic							
Sample method:	Peristaltic							
Start time:	10:23	Odor: None						
Stop time:	10:42	Purge Appearance: clear						
Duration: (minutes)	19	Sample Appearance: clear						
Rate, gpm:	0.5	Comments:						
Volume, purged:	9.5 gal							
Duplicate collected?	Yes							
Sample collection by:	JAM2	CO2-	Mn2-	Fe(T)-	Fe2-			
Others present:	—	Well Condition: Good						

(MW): groundwater monitoring well WS: water supply well SW: surface water SE: sediment other:

VOC- semi-volatile- general- 4 nutrient- 4 cyanide- 2 DRO- Sulfide-

oil,grease- bacteria- total metal- 4 filtered metal- 4 methane- filter-

Others:

*Measurements are referenced from top of riser pipe, unless otherwise indicated.

Barr Engineering Company
Field Log Data Sheet

Client: PolyMet Mining Corp.	**Monitoring Point:** MW-05-09
Location: NorthMet	**Date:** 3/23/05
Project #: 23/69-862-004-005	**Sample Time:** 8:58

GENERAL DATA	
Barr lock:	Yes
Casing diameter:	2"
Total well depth:*	16.15
Static water level:*	10.11
Water depth:*	6.04
Well volume: (gal)	0.98
Purge method:	Peristaltic
Sample method:	Peristaltic
Start time:	8:37
Stop time:	8:48
Duration: (minutes)	11
Rate, gpm:	0.25
Volume, purged:	2.75
Duplicate collected?	No
Sample collection by:	JAM2

STABILIZATION TEST

Time/ Volume	Temp. °C	mS/cm³ Cond. @ 25	pH	ORP Eh	D.O.	Turbidity Appearance
1 min	3.65	0.122	7.29	183.9	✓	Clear
3 min	3.77	0.115	6.60	208.2	✓	↓
5 min	3.95	0.132	6.51	202.5	✓	↓
7 min	4.09	0.140	6.59	190.6	✓	↓
11 min	4.20	0.139	6.62	187.8	✓	↓

Odor: None

Purge Appearance: Clear

Sample Appearance: Clear

Comments: Purged dry after 11 minutes, wait 10 minutes then sample

CO2- Mn2- Fe(T)- Fe2-

Others present: —

Well Condition:

MW: groundwater monitoring well WS: water supply well SW: surface water SE: sediment other:

VOC- semi-volatile- general- 2 nutrient- 2 cyanide- 1 DRO- Sulfide-

oil,grease- bacteria- total metal- 2 filtered metal- 2 methane- filter-

Others:

*Measurements are referenced from top of riser pipe, unless otherwise indicated.

Appendix D

Appendix D
Groundwater Analytical Data Reports

NOTE:
At the time of sample collection, the names of the exploratory boreholes were unknown and temporary names were given to the samples collected from these boreholes. The table below shows the temporary borehole names and the actual borehole names. The temporary names are used in this appendix, while the actual borehole names are used throughout the report.

Actual Borehole Name	Temporary Borehole Name
05-407M	26100
05-401M	East

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID:	S050691455	Project #:	
Client:	Barr Engineering		
Study:	Consultant		
Descript:	PolyMet		
Location:	26100		

Sampler: Client
Status: Normal
NTS COC No: 47646
Sampled: 3/10/2005 9:30 AM
Completed: 04/13/2005

Type: Grab
Matrix: Liquid

RECEIVED
APR 18 2005
BARR ENGINEERING CO.

Notes:

23/69-862

High solids.
c: Elevated reporting limit due to matrix effects.

Analyte	Analysis Date	Result	Units	RL	Method
Alkalinity, Total as CaCO3	3/24/2005	93.7	mg/L	10	310.1
Aluminum	3/17/2005	39900	ug/L	250	200.7
Antimony	3/24/2005	<3	ug/L	3	204.2
Arsenic	3/25/2005	4.4	ug/L	2	206.2
Barium	3/17/2005	92.1	ug/L	10	6010B/200.7
Beryllium	3/21/2005	0.8	ug/L	0.2	210.2
Boron	3/17/2005	183	ug/L	35	200.7
Cadmium	3/21/2005	<0.2	ug/L	0.2	213.2
Calcium	3/17/2005	38.5	mg/L	0.5	200.7
Chloride	3/22/2005	2.7	mg/L	0.5	325.2
Chromium	3/23/2005	42	ug/L	1	218.2
Cobalt	3/23/2005	19.9	ug/L	1	219.2
COD	3/25/2005	33.9	mg/L	10	SM 5220-D
Copper	3/17/2005	587	ug/L	5	200.7
Cyanide	3/18/2005	<0.02	mg/L	0.02	335.2
Fluoride	3/21/2005	0.49	mg/L	0.1	340.2
Hardness (Calculated)	4/13/2005	149	mg/L	1	200.7
Iron	3/17/2005	24.5	mg/L	0.3	200.7
Lead, GF	3/23/2005	9.5	ug/L	1	239.2
Magnesium	3/17/2005	12.8	mg/L	0.5	200.7
Manganese	3/17/2005	0.2	mg/L	0.01	200.7
Mercury, Low Level	3/18/2005	3.4	ng/L	0.5	1631E

Approved By: _____
Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID:	S050691455	Project #:	
Client:	Barr Engineering		
Study:	Consultant		
Descript:	PolyMet		
Location:	26100		

Sampler: Client
Type: Grab
Status: Normal
Matrix: Liquid
NTS COC No: 47646
Sampled: 3/10/2005 9:30 AM
Completed: 04/13/2005

Notes:

High solids.
c: Elevated reporting limit due to matrix effects.

Analyte	Analysis Date	Result	Units	RL	Method
Mercury, Methyl	3/22/2005	<0.025	ng/L	0.025	1631E
Molybdenum, GF	3/21/2005	<5	ug/L	5	246.2
Nickel	3/17/2005	172	ug/L	5	200.7
Nitrogen, Ammonia	3/16/2005	1.9	mg/L	0.1	350.1
Nitrogen, Nitrate + Nitrite	3/15/2005	<0.1	mg/L	0.1	353.2
Palladium	3/17/2005	c<50	ug/L	50	200.7
pH	3/11/2005	9.8	SU	0.1	150.1
Phosphorous, Total	3/17/2005	1.1	mg/L	0.1	365.4
Platinum	3/17/2005	<25	ug/L	25	200.7
Potassium	3/17/2005	5.2	mg/L	2	200.7
Selenium, GF	3/29/2005	<2	ug/L	2	270.2
Silver	3/24/2005	7.4	ug/L	1	272.2
Sodium	3/17/2005	38.2	mg/L	0.5	200.7
Strontium	3/17/2005	143	ug/L	4	200.7
Sulfate	3/18/2005	24.7	mg/L	1	375.4
Thallium	3/24/2005	<2	ug/L	2	279.2
Titanium	3/30/2005	765	ug/L	100	283.2
TOC	3/17/2005	2.6	mg/L	1	415.1
Zinc	3/17/2005	46.8	ug/L	10	200.7

Approved By: MM
Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID: S050691501 | Project #:

Client: Barr Engineering
Study: Consultant
Descript: PolyMet
Location: East

Sampler: Client
Status: Normal
NTS COC No: 47646
Sampled: 3/10/2005 11:30 AM
Completed: 04/13/2005

Type: Grab
Matrix: Liquid

Notes:

Clean sample

Analyte	Analysis Date	Result	Units	RL	Method
Alkalinity, Total as CaCO3	3/24/2005	106	mg/L	10	310.1
Aluminum	3/17/2005	3170	ug/L	25	200.7
Antimony	3/24/2005	<3	ug/L	3	204.2
Arsenic	3/25/2005	<2	ug/L	2	206.2
Barium	3/17/2005	<10	ug/L	10	6010B/200.7
Beryllium	3/21/2005	<0.2	ug/L	0.2	210.2
Boron	3/17/2005	<35	ug/L	35	200.7
Cadmium	3/21/2005	<0.2	ug/L	0.2	213.2
Calcium	3/17/2005	20.5	mg/L	0.5	200.7
Chloride	3/22/2005	1.7	mg/L	0.5	325.2
Chromium	3/23/2005	4.6	ug/L	1	218.2
Cobalt	3/23/2005	2.2	ug/L	1	219.2
COD	3/25/2005	17.7	mg/L	10	SM 5220-D
Copper	3/17/2005	53.3	ug/L	5	200.7
Cyanide	3/18/2005	<0.02	mg/L	0.02	335.2
Fluoride	3/21/2005	0.14	mg/L	0.1	340.2
Hardness (Calculated)	4/13/2005	61.7	mg/L	1	200.7
Iron	3/17/2005	3.05	mg/L	0.03	200.7
Lead, GF	3/23/2005	<1	ug/L	1	239.2
Magnesium	3/17/2005	12.2	mg/L	0.5	200.7
Manganese	3/17/2005	0.14	mg/L	0.01	200.7
Mercury, Low Level	3/18/2005	1	ng/L	0.5	1631E

Approved By: _____
Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID: S050691501 | Project #:

Sampler: Client | Type: Grab

Status: Normal | Matrix: Liquid

Client: Barr Engineering

Study: Consultant

Descript: PolyMet

Location: East

NTS COC No: 47646

Sampled: 3/10/2005 11:30 AM

Completed: 04/13/2005

Notes:

Clean sample

Analyte	Analysis Date	Result	Units	RL	Method
Mercury, Methyl	3/22/2005	<0.025	ng/L	0.025	1631E
Molybdenum, GF	3/21/2005	<5	ug/L	5	246.2
Nickel	3/17/2005	18.3	ug/L	5	200.7
Nitrogen, Ammonia	3/16/2005	0.61	mg/L	0.1	350.1
Nitrogen, Nitrate + Nitrite	3/15/2005	<0.1	mg/L	0.1	353.2
Palladium	3/17/2005	<25	ug/L	25	200.7
pH	3/11/2005	8.1	SU	0.1	150.1
Phosphorous, Total	3/17/2005	0.2	mg/L	0.1	365.4
Platinum	3/17/2005	<25	ug/L	25	200.7
Potassium	3/17/2005	1.9	mg/L	0.2	200.7
Selenium, GF	3/29/2005	<2	ug/L	2	270.2
Silver	3/24/2005	1.1	ug/L	1	272.2
Sodium	3/17/2005	8.6	mg/L	0.5	200.7
Strontium	3/17/2005	48	ug/L	4	200.7
Sulfate	3/18/2005	13.6	mg/L	1	375.4
Thallium	3/24/2005	<2	ug/L	2	279.2
Titanium	3/30/2005	66.8	ug/L	10	283.2
TOC	3/18/2005	3.9	mg/L	1	415.1
Zinc	3/17/2005	<10	ug/L	10	200.7

Approved By: _____

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID: S050691502 Project #:

Client: Barr Engineering
Study: Consultant
Descript: PolyMet
Location: 26100

Sampler: Client
Status: Normal
NTS COC No: 47646
Sampled: 3/10/2005 9:30 AM
Completed: 03/31/2005

Type: Grab - Filtered
Matrix: Liquid

Notes:

Dirty looking sample.

Analyte	Analysis Date	Result	Units	RL	Method
Aluminum	3/15/2005	126	ug/L	25	200.7
Cadmium	3/30/2005	<0.2	ug/L	0.2	213.2
Chromium	3/29/2005	<1	ug/L	1	218.2
Copper	3/29/2005	<2	ug/L	2	220.2
Molybdenum, GF	3/29/2005	<5	ug/L	5	246.2
Nickel	3/29/2005	<2	ug/L	2	249.2
Selenium, GF	3/29/2005	<2	ug/L	2	270.2
Silver	3/25/2005	<1	ug/L	1	272.2
Zinc	3/15/2005	<10	ug/L	10	200.7

Approved By: _____

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID: S050691503	Project #:	Sampler: Client	Type: Grab - Filtered
Client: Barr Engineering		Status: Normal	Matrix: Liquid
Study: Consultant		NTS COC No: 47646	
Descript: PolyMet		Sampled: 3/10/2005 11:30 AM	
Location: East		Completed: 03/31/2005	

Notes:

Clean sample.

Analyte	Analysis Date	Result	Units	RL	Method
Aluminum	3/15/2005	62.5	ug/L	25	200.7
Cadmium	3/30/2005	<0.2	ug/L	0.2	213.2
Chromium	3/29/2005	<1	ug/L	1	218.2
Copper	3/29/2005	2.2	ug/L	2	220.2
Molybdenum, GF	3/29/2005	<5	ug/L	5	246.2
Nickel	3/29/2005	6.2	ug/L	2	249.2
Selenium, GF	3/29/2005	<2	ug/L	2	270.2
Silver	3/25/2005	<1	ug/L	1	272.2
Zinc	3/15/2005	<10	ug/L	10	200.7

Approved By: _____

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID: S05069150A	Project #:	Sampler: Client	Type: Grab
Client: Barr Engineering		Status: Normal	Matrix: Liquid
Study: Consultant		NTS COC No: 47646	
Descript: PolyMet		Sampled: 3/10/2005 10:00 AM	
Location: Equipment Blank		Completed: 03/21/2005	

Notes:

Analyte	Analysis Date	Result	Units	RL	Method
Mercury, LL Equipment Blan	3/18/2005	0.4	ng/L	0.2	1631E

Approved By:

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

Frontier GeoSciences Inc.

414 Pontius Ave N
Seattle, WA 98109

206-622-6960
fax 206-622-6870

April 5, 2005

Renee Stone
Northeast Technical Services
315 Chestnut Street
P.O. Box 1142
Virginia, MN 55792

RE: Methyl Mercury in Aqueous Samples

Dear Ms. Stone,

Enclosed are the results for methyl Hg in the water samples collected on March 10, 2005. The samples were received by Frontier in good condition on March 11, 2005 within a sealed cooler at 3.1 °C.

Immediately following sample receipt, the samples for methyl mercury were preserved with 0.4% (v/v) hydrochloric acid and placed into refrigerated storage. Methyl mercury in water analysis was determined by distillation, aqueous phase ethylation, isothermal GC separation, and cold vapor atomic fluorescence spectrometry (CVAFS) detection. Analysis was performed on March 22, 2005 according to Frontier's standard operating procedure (SOP) FGS-070.

Analytical Issues:

There were no analytical issues to report and all quality control were within acceptable limits. Please note that the samples arrived without any unique identification. The numbers listed on the COC were not written on the samples themselves. The sample custodian assigned the label "A Clear" to the sample without any visible particulate, and the label "B Cloudy" to the sample with visible particulate matter.

Please feel free to contact me with any questions regarding this report.

Sincerely,

Laura Daniels
Project Coordinator
laurad@frontiergeosciences.com

Methyl Mercury in Aqueous Samples

Northeast Technical Services c/o Renee Stone

analyzed by:
Frontier Geosciences, Inc.
414 Pontius Avenue North, Seattle, WA 98109
phone: (206) 622-6960 fax: (206) 622-6870

Samples analyzed: March 22, 2005 (MHG7-050322-1)

Sample Identification	Date Collected	Methyl Hg, ng/L (ppt)*
A Clear ☼	3/10/05	ND (<0.025)
B Cloudy ☼	3/10/05	ND (<0.025)

☼= Sample ID assigned upon reciept, please see narrative

*Blank corrected

ND-Sample concentration below reporting limit.

Methyl Mercury in Aqueous Samples

Northeast Technical Services c/o Renee Stone

analyzed by:
Frontier Geosciences, Inc.
414 Pontius Avenue North, Seattle, WA 98109
phone: (206) 622-6960 fax: (206) 622-6870

Samples analyzed: March 22, 2005 (MHG7-050322-1)

Sample Identification	Methyl Hg, ng/L (ppt)

Method blanks

Blank-1	0.010
Blank-2	0.021
Blank-3	0.009
Mean	**0.013**
Estimated MDL	**0.020**
Reporting Limit	**0.025**

Estimated MDL = 3 x standard deviation of the method blanks

Certified Reference Material

DORM-2	4,545 ng/L
recovery	**101.7%**
reference value	4,470 ng/L

Acceptance limit: 75-125%

Methyl Mercury in Aqueous Samples

Northeast Technical Services c/o Renee Stone

analyzed by:
Frontier Geosciences, Inc.
414 Pontius Avenue North, Seattle, WA 98109
phone: (206) 622-6960 fax: (206) 622-6870

Samples analyzed: March 22, 2005 (MHG7-050322-1)

Sample Identification	Date Collected	Methyl Hg, ng/L (ppt)*

Analytical Replicates

Batch QC	-	1.451
Methed Duplicate	-	1.399
Mean		**1.425**
RPD		**3.6%**

Acceptance limit: 25%

*Blank corrected

Methyl Mercury in Aqueous Samples

Northeast Technical Services c/o Renee Stone

analyzed by:
Frontier Geosciences, Inc.
414 Pontius Avenue North, Seattle, WA 98109
phone: (206) 622-6960 fax: (206) 622-6870

Samples analyzed: March 22, 2005 (MHG7-050322-1)

Sample Identification	Date Collected	Methyl Hg, ng/L (ppt)*

Matrix Spikes

Batch QC	-	0.340
Sample MS	-	2.521
spiking level		2.000
net		2.181
recovery		**109.1%**
Sample MSD	-	2.495
spiking level		2.000
net		2.155
recovery		**107.8%**
RPD		**1.2**

Acceptance limit: 75-125%

MS-matrix spike

MSD-matrix spike duplicate

RPD-relative percent deviation

*Blank corrected

NTS #6845

P.M. Amy

Chain of Custody Record

Custody Name: COC#47646

Samplers Signature:

Sample ID	Collected		Type	Location	Total #	Containers	Remarks
* S050691501	3/10/05	11:30:00 AM	Grab	East	H20	1	Methyl Mercury M.1630
* S050691455	3/10/05	9:30:00 AM	Grab	26100	H20	1	Methyl Mercury M.1630

Relinquished By: (Signature)	Date	Time	Received By: (Signature)	Relinquished By: (Signature)	Date	Time	Received By: (Signature)
J Kosich	3-10-05	15:27	Amber Steward				
Relinquished By: (Signature)	Date	Time	Received By: (Signature)	Relinquished By: (Signature)	Date	Time	Received By: (Signature)
Relinquished By: (Signature)	Date	Time	Received for Laboratory By: (Signature)	Date	Time	Remarks	
			Amber Steward Amber Steward	3/11/05	1200	Split Samples	

Releasing Agency:

NTS
315 Chestnut Street
PO Box 1142
Virginia MN 55792-

VSTR: 0930 PST
cooler temp 3.1°C
COC seal intact? yes.

Signature

☐ Accepted ☐ Declined

3/10/05 3:26:35 PM

* Rename samples "A Clear" and "B Cloudy". Samples arrived with no unique IDs. 3.11.05 as

NORTHEAST TECHNICAL SERVICES, INC.

315 Chestnut Street PO Box 1142
Virginia, MN 55792
(218)741-4290 Fax (218) 741-4291

CHAIN OF CUSTODY RECORD
PAGE 1 OF 1
COC# 470446

CLIENT NAME, ADDRESS, PHONE# :	INVOICE TO:	REPORT TO:
Barr Engineering 332 W Superior St Duluth, MN 55802	Barr Engineering 4700 W 77th St Mpls, MN	Tina Pint 4700 W 77th St Mpls, MN

PROJECT:	SAMPLER:	PERMIT REQ.:
PolyMet	Jeré Mohr	

PROJ. NO: 6845.

NTS LOG-IN NO:	DESCRIPTION:	SAMPLE COLLECTION DATE START DATE:	SAMPLE COLLECTION DATE END DATE:	SAMPLE COLLECTION TIME START TIME:	SAMPLE COLLECTION TIME END TIME:	SAMPLE TYPE COMP	SAMPLE TYPE GRAB	MATRIX LIQ.	MATRIX SOL.	filter	CONTAINERS GENERAL - NO PRES.	CONTAINERS NUTRIENTS - H2SO4	CONTAINERS METALS - HNO3	CONTAINERS 40ML VIALS -HCL	CONTAINERS 1LT AMBER -HCL NaOH	CONTAINERS 100ML - NATHIO	ANALYSIS:
S05069 1455 1502	26100	3/10/05 →		9:30	—		X	X	~~X~~	X	4	2	2		1		See attached
1501 1503	East	3/10/05 →		11:30	—		X	X		X	4	2	2		1		See attached
150A	Equip. Blank	3/10/05 →		10:00	—		X	X			1						Total LL Hg M.1631

SPECIAL INSTRUCTIONS:

SAMPLED BY:	RELINQUISHED BY:	DATE: 3/10/05	RELINQUISHED TO NTS SAMPLE LOCK-UP:	DATE:
Jeré Mohr	Jeré A. Mohr	TIME: 13:40		TIME:
RELINQUISHED BY: DATE: TIME:	RECEIVED BY:	DATE: TIME:	RECEIVED FROM NTS SAMPLE LOCK-UP:	DATE: TIME:
RECEIVED BY: DATE: TIME:	RELINQUISHED BY:	DATE: TIME:	RECEIVED FOR LAB BY: M Koski	DATE: 3-10-05 TIME: 13.40 SAMPLE TEMP: 4.0 c

on ice

23/69-8622004005

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID: S050821534	**Project #:** 6845	**Sampler:** Client	**Type:** Grab
Client: Barr Engineering		**Status:** Normal	**Matrix:** Liquid
Study: Consultant		**NTS COC No:** 47825	
Descript: PolyMet		**Sampled:** 3/23/2005 12:00 PM	
Location: MW-05-02		**Completed:** 04/29/2005	

Notes:

a- Laboratory control spike not within control limits = 84%.
n Matrix Spike recovery not within control limits, recovery 118%.
**Reporting limit raised for mercury due to matrix interference.*

RECEIVED
MAY 06 2005
BARR ENGINEERING CO.

Analyte	Analysis Date	Result	Units	RL	Method
Alkalinity, Total as CaCO3	3/29/2005	88.3	mg/L	10	310.1
Aluminum	4/5/2005	322	ug/L	25	200.7
Antimony	3/31/2005	<3	ug/L	3	204.2
Arsenic	3/30/2005	3.2	ug/L	2	206.2
Barium	4/5/2005	<10	ug/L	10	6010B/200.7
Beryllium	3/31/2005	<0.2	ug/L	0.2	210.2
Boron	4/5/2005	<35	ug/L	35	200.7
Cadmium	3/31/2005	<0.2	ug/L	0.2	213.2
Calcium	4/5/2005	30.1	mg/L	0.5	200.7
Chloride	4/4/2005	1.3	mg/L	0.5	325.2
Chromium	4/11/2005	1.2	ug/L	1	218.2
Cobalt	4/11/2005	<1	ug/L	1	219.2
COD	3/29/2005	12.4	mg/L	10	SM 5220-D
Copper	4/11/2005	11.2	ug/L	2	220.2
Cyanide	3/29/2005	<0.02	mg/L	0.02	335.2
Fluoride	4/4/2005	0.21	mg/L	0.1	340.2
Hardness (Calculated)	4/14/2005	84.8	mg/L	1	200.7
Iron	4/5/2005	0.35	mg/L	0.05	200.7
Lead	4/4/2005	<1	ug/L	1	7421
Magnesium	4/5/2005	2.3	mg/L	0.5	200.7
Manganese	4/5/2005	<0.03	mg/L	0.03	200.7
Mercury, Low Level	4/18/2005	*<2	ng/L	2	1631E

Approved By:

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID: S050821534	**Project #:** 6845	**Sampler:** Client	**Type:** Grab
Client: Barr Engineering		**Status:** Normal	**Matrix:** Liquid
Study: Consultant		**NTS COC No:** 47825	
Descript: PolyMet		**Sampled:** 3/23/2005 12:00 PM	
Location: MW-05-02		**Completed:** 04/29/2005	

Notes:

a- Laboratory control spike not within control limits = 84%.
n Matrix Spike recovery not within control limits, recovery 118%.
**Reporting limit raised for mercury due to matrix interference.*

Analyte	Analysis Date	Result	Units	RL	Method
Mercury, Methyl	4/15/2005	<0.025	ng/L	0.02	1631E
Molybdenum, GF	3/31/2005	a 16.1	ug/L	5	246.2
Nickel	4/11/2005	<2	ug/L	2	249.2
Nitrogen, Ammonia	3/30/2005	0.24	mg/L	0.1	350.1
Nitrogen, Nitrate + Nitrite	4/4/2005	0.33	mg/L	0.1	353.2
Palladium	4/5/2005	<25	ug/L	25	200.7
pH	3/25/2005	10	SU	0.1	150.1
Phosphorous, Total	3/30/2005	0.14	mg/L	0.1	365.4
Platinum	4/5/2005	<25	ug/L	25	200.7
Potassium	4/5/2005	n 1.6	mg/L	1	200.7
Selenium, GF	3/30/2005	<2	ug/L	2	270.2
Silver	4/3/2005	<1	ug/L	1	272.2
Sodium	4/5/2005	11.9	mg/L	0.5	200.7
Strontium	4/5/2005	191	ug/L	4	200.7
Sulfate	4/6/2005	10.8	mg/L	1	375.4
Thallium	3/31/2005	<2	ug/L	2	279.2
Titanium	4/1/2005	30.7	ug/L	10	283.2
TOC	4/4/2005	8	mg/L	1	415.1
Zinc	4/5/2005	<10	ug/L	10	200.7

Approved By: mk

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID:	S050821543	**Project #:**	6845	**Sampler:** Client	**Type:** Grab
Client:	Barr Engineering			**Status:** Normal	**Matrix:** Liquid
Study:	Consultant			**NTS COC No:** 47825	
Descript:	PolyMet			**Sampled:** 3/23/2005 10:45 AM	
Location:	MW-05-08			**Completed:** 04/29/2005	

Notes:

a- Laboratory control spike not within control limits = 84%.
n Matrix Spike recovery not within control limits, recovery 118%.

Analyte	Analysis Date	Result	Units	RL	Method
Alkalinity, Total as CaCO3	3/29/2005	72.8	mg/L	10	310.1
Aluminum	4/5/2005	1040	ug/L	25	200.7
Antimony	3/31/2005	<3	ug/L	3	204.2
Arsenic	3/30/2005	4.4	ug/L	2	206.2
Barium	4/5/2005	32.5	ug/L	10	6010B/200.7
Beryllium	3/31/2005	<0.2	ug/L	0.2	210.2
Boron	4/5/2005	<35	ug/L	35	200.7
Cadmium	3/31/2005	<0.2	ug/L	0.2	213.2
Calcium	4/5/2005	14.5	mg/L	0.5	200.7
Chloride	4/4/2005	1.1	mg/L	0.5	325.2
Chromium	4/11/2005	6.1	ug/L	1	218.2
Cobalt	4/11/2005	1.8	ug/L	1	219.2
COD	3/29/2005	12.4	mg/L	10	SM 5220-D
Copper	4/11/2005	10	ug/L	2	220.2
Cyanide	3/29/2005	<0.02	mg/L	0.02	335.2
Fluoride	4/4/2005	0.19	mg/L	0.1	340.2
Hardness (Calculated)	4/14/2005	64.3	mg/L	1	200.7
Iron	4/5/2005	1.74	mg/L	0.05	200.7
Lead	4/4/2005	<1	ug/L	1	7421
Magnesium	4/5/2005	6.8	mg/L	0.5	200.7
Manganese	4/5/2005	0.22	mg/L	0.03	200.7
Mercury, Low Level	4/15/2005	5.3	ng/L	2	1631E

Approved By:

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID:	S050821543	**Project #:**	6845	**Sampler:** Client	**Type:** Grab
Client:	Barr Engineering			**Status:** Normal	**Matrix:** Liquid
Study:	Consultant			**NTS COC No:** 47825	
Descript:	PolyMet			**Sampled:** 3/23/2005 10:45 AM	
Location:	MW-05-08			**Completed:** 04/29/2005	

Notes:

a- Laboratory control spike not within control limits = 84%.
n Matrix Spike recovery not within control limits, recovery 118%.

Analyte	Analysis Date	Result	Units	RL	Method
Mercury, Methyl	4/15/2005	<0.025	ng/L	0.02	1631E
Molybdenum, GF	3/31/2005	a 35.6	ug/L	5	246.2
Nickel	4/11/2005	7.9	ug/L	2	249.2
Nitrogen, Ammonia	3/30/2005	<0.1	mg/L	0.1	350.1
Nitrogen, Nitrate + Nitrite	4/4/2005	0.31	mg/L	0.1	353.2
Palladium	4/5/2005	<25	ug/L	25	200.7
pH	3/25/2005	7.4	SU	0.1	150.1
Phosphorous, Total	3/30/2005	0.17	mg/L	0.1	365.4
Platinum	4/5/2005	<25	ug/L	25	200.7
Potassium	4/5/2005	n 1.6	mg/L	0.4	200.7
Selenium, GF	3/30/2005	<2	ug/L	2	270.2
Silver	4/3/2005	<1	ug/L	1	272.2
Sodium	4/5/2005	15.7	mg/L	0.5	200.7
Strontium	4/5/2005	35.9	ug/L	4	200.7
Sulfate	4/6/2005	21.2	mg/L	1	375.4
Thallium	3/31/2005	<2	ug/L	2	279.2
Titanium	4/1/2005	113	ug/L	10	283.2
TOC	4/4/2005	3.8	mg/L	1	415.1
Zinc	4/5/2005	<10	ug/L	10	200.7

Approved By: _____
Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID:	S050821544	**Project #:**	6845	**Sampler:** Client	**Type:** Grab
Client:	Barr Engineering			**Status:** Normal	**Matrix:** Liquid
Study:	Consultant			**NTS COC No:** 47825	
Descript:	PolyMet			**Sampled:** 3/23/2005 12:30 PM	
Location:	Supply Well			**Completed:** 04/29/2005	

Notes:

a- Laboratory control spike not within control limits = 84%.
n Matrix Spike recovery not within control limits, recovery 118%.

Analyte	Analysis Date	Result	Units	RL	Method
Alkalinity, Total as CaCO3	3/29/2005	95.2	mg/L	10	310.1
Aluminum	4/5/2005	<25	ug/L	25	200.7
Antimony	3/31/2005	<3	ug/L	3	204.2
Arsenic	3/30/2005	<2	ug/L	2	206.2
Barium	4/5/2005	<10	ug/L	10	6010B/200.7
Beryllium	3/31/2005	<0.2	ug/L	0.2	210.2
Boron	4/5/2005	128	ug/L	35	200.7
Cadmium	3/31/2005	<0.2	ug/L	0.2	213.2
Calcium	4/5/2005	12	mg/L	0.5	200.7
Chloride	4/4/2005	0.5	mg/L	0.5	325.2
Chromium	4/11/2005	<1	ug/L	1	218.2
Cobalt	4/11/2005	<1	ug/L	1	219.2
COD	3/29/2005	9.7	mg/L	2	SM 5220-D
Copper	4/11/2005	<2	ug/L	2	220.2
Cyanide	3/29/2005	<0.02	mg/L	0.02	335.2
Fluoride	4/4/2005	0.25	mg/L	0.1	340.2
Hardness (Calculated)	4/14/2005	60.4	mg/L	1	200.7
Iron	4/5/2005	0.06	mg/L	0.05	200.7
Lead	4/4/2005	<1	ug/L	1	7421
Magnesium	4/5/2005	7.4	mg/L	0.5	200.7
Manganese	4/5/2005	<0.03	mg/L	0.03	200.7
Mercury, Low Level	4/15/2005	<0.5	ng/L	0.5	1631E

Approved By:

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID:	S050821544	**Project #:**	6845	**Sampler:** Client	**Type:** Grab
Client:	Barr Engineering			**Status:** Normal	**Matrix:** Liquid
Study:	Consultant			**NTS COC No:** 47825	
Descript:	PolyMet			**Sampled:** 3/23/2005 12:30 PM	
Location:	Supply Well			**Completed:** 04/29/2005	

Notes:

a- Laboratory control spike not within control limits = 84%.
n Matrix Spike recovery not within control limits, recovery 118%.

Analyte	Analysis Date	Result	Units	RL	Method
Mercury, Methyl	4/15/2005	<0.025	ng/L	0.02	1631E
Molybdenum, GF	3/31/2005	a<5	ug/L	5	246.2
Nickel	4/11/2005	<2	ug/L	2	249.2
Nitrogen, Ammonia	3/30/2005	<0.1	mg/L	0.1	350.1
Nitrogen, Nitrate + Nitrite	4/4/2005	<0.1	mg/L	0.1	353.2
Palladium	4/5/2005	<25	ug/L	25	200.7
pH	3/25/2005	8.7	SU	0.1	150.1
Phosphorous, Total	3/30/2005	<0.1	mg/L	0.1	365.4
Platinum	4/5/2005	<25	ug/L	25	200.7
Potassium	4/5/2005	n 1.4	mg/L	0.4	200.7
Selenium, GF	3/30/2005	<2	ug/L	2	270.2
Silver	4/3/2005	<1	ug/L	1	272.2
Sodium	4/5/2005	20.2	mg/L	0.5	200.7
Strontium	4/5/2005	46.5	ug/L	4	200.7
Sulfate	4/6/2005	4.4	mg/L	1	375.4
Thallium	3/31/2005	<2	ug/L	2	279.2
Titanium	4/1/2005	<10	ug/L	10	283.2
TOC	4/4/2005	3.9	mg/L	1	415.1
Zinc	4/5/2005	<10	ug/L	10	200.7

Approved By: _____
Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID:	S05082154A	**Project #:**	6845	**Sampler:** Client	**Type:** Grab
Client:	Barr Engineering			**Status:** Normal	**Matrix:** Liquid
Study:	Consultant			**NTS COC No:** 47825	
Descript:	PolyMet			**Sampled:** 3/23/2005	
Location:	Duplicate			**Completed:** 04/29/2005	

Notes:

a- Laboratory control spike not within control limits = 84%.
n Matrix Spike recovery not within control limits, recovery 118%.

Analyte	Analysis Date	Result	Units	RL	Method
Alkalinity, Total as CaCO3	3/29/2005	65.2	mg/L	10	310.1
Aluminum	4/5/2005	1300	ug/L	25	200.7
Antimony	3/31/2005	<3	ug/L	3	204.2
Arsenic	3/30/2005	3.1	ug/L	2	206.2
Barium	4/5/2005	32	ug/L	10	6010B/200.7
Beryllium	3/31/2005	<0.2	ug/L	0.2	210.2
Boron	4/5/2005	38	ug/L	35	200.7
Cadmium	3/31/2005	<0.2	ug/L	0.2	213.2
Calcium	4/5/2005	14.9	mg/L	0.5	200.7
Chloride	4/4/2005	1.3	mg/L	0.5	325.2
Chromium	4/11/2005	4.8	ug/L	1	218.2
Cobalt	4/11/2005	1.6	ug/L	1	219.2
COD	3/29/2005	8.8	mg/L	10	SM 5220-D
Copper	4/11/2005	7.8	ug/L	2	220.2
Cyanide	3/29/2005	<0.02	mg/L	0.02	335.2
Fluoride	4/4/2005	0.19	mg/L	0.1	340.2
Hardness (Calculated)	4/14/2005	66.1	mg/L	1	200.7
Iron	4/5/2005	1.94	mg/L	0.05	200.7
Lead	4/4/2005	<1	ug/L	1	7421
Magnesium	4/5/2005	7	mg/L	0.5	200.7
Manganese	4/5/2005	0.22	mg/L	0.03	200.7
Mercury, Low Level	4/15/2005	3.6	ng/L	2	1631E

Approved By:

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID: S05082154A **Project #:** 6845	**Sampler:** Client	**Type:** Grab
Client: Barr Engineering	**Status:** Normal	**Matrix:** Liquid
Study: Consultant	**NTS COC No:** 47825	
Descript: PolyMet	**Sampled:** 3/23/2005	
Location: Duplicate	**Completed:** 04/29/2005	

Notes:

a- Laboratory control spike not within control limits = 84%.
n Matrix Spike recovery not within control limits, recovery 118%.

Analyte	Analysis Date	Result	Units	RL	Method
Mercury, Methyl	4/15/2005	<0.025	ng/L	0.02	1631E
Molybdenum, GF	3/31/2005	a 33.1	ug/L	5	246.2
Nickel	4/11/2005	6.2	ug/L	2	249.2
Nitrogen, Ammonia	3/30/2005	<0.1	mg/L	0.1	350.1
Nitrogen, Nitrate + Nitrite	4/4/2005	0.9	mg/L	0.1	353.2
Palladium	4/5/2005	<25	ug/L	25	200.7
pH	3/25/2005	7.7	SU	0.1	150.1
Phosphorous, Total	3/30/2005	0.16	mg/L	0.1	365.4
Platinum	4/5/2005	<25	ug/L	25	200.7
Potassium	4/5/2005	n 1.6	mg/L	0.4	200.7
Selenium, GF	3/30/2005	<2	ug/L	2	270.2
Silver	4/3/2005	<1	ug/L	1	272.2
Sodium	4/5/2005	13.5	mg/L	0.5	200.7
Strontium	4/5/2005	37.1	ug/L	4	200.7
Sulfate	4/6/2005	20.3	mg/L	1	375.4
Thallium	3/31/2005	<2	ug/L	2	279.2
Titanium	4/1/2005	82.6	ug/L	10	283.2
TOC	4/4/2005	3.3	mg/L	1	415.1
Zinc	4/5/2005	<10	ug/L	10	200.7

Approved By: _____
Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID:	S05082154B	**Project #:**	6845	**Sampler:** Client	**Type:** Grab
Client:	Barr Engineering			**Status:** Normal	**Matrix:** Liquid
Study:	Consultant			**NTS COC No:** 47825	
Descript:	PolyMet			**Sampled:** 3/23/2005 8:58 AM	
Location:	MW-05-09			**Completed:** 04/29/2005	

Notes:

a- Laboratory control spike not within control limits = 84%.
n Matrix Spike recovery not within control limits, recovery 118%.

Analyte	Analysis Date	Result	Units	RL	Method
Alkalinity, Total as CaCO3	3/29/2005	47	mg/L	10	310.1
Aluminum	4/5/2005	4640	ug/L	25	200.7
Antimony	3/31/2005	<3	ug/L	3	204.2
Arsenic	3/30/2005	3.4	ug/L	2	206.2
Barium	4/5/2005	90.7	ug/L	10	6010B/200.7
Beryllium	3/31/2005	0.3	ug/L	0.2	210.2
Boron	4/5/2005	40.2	ug/L	35	200.7
Cadmium	3/31/2005	<0.2	ug/L	0.2	213.2
Calcium	4/5/2005	12.1	mg/L	0.5	200.7
Chloride	4/4/2005	5.5	mg/L	0.5	325.2
Chromium	4/11/2005	28.6	ug/L	1	218.2
Cobalt	4/11/2005	5.4	ug/L	1	219.2
COD	3/29/2005	6.9	mg/L	10	SM 5220-D
Copper	4/5/2005	72.2	ug/L	10	200.7
Cyanide	3/29/2005	<0.02	mg/L	0.02	335.2
Fluoride	4/4/2005	0.1	mg/L	0.1	340.2
Hardness (Calculated)	4/14/2005	53.4	mg/L	1	200.7
Iron	4/5/2005	6.4	mg/L	0.05	200.7
Lead	4/4/2005	5.6	ug/L	1	7421
Magnesium	4/5/2005	5.7	mg/L	0.5	200.7
Manganese	4/5/2005	0.33	mg/L	0.03	200.7
Mercury, Low Level	4/15/2005	18.1	ng/L	2	1631E

Approved By: _____

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

Sample ID:	S05082154B	**Project #:**	6845	**Sampler:** Client	**Type:** Grab
Client:	Barr Engineering			**Status:** Normal	**Matrix:** Liquid
Study:	Consultant			**NTS COC No:** 47825	
Descript:	PolyMet			**Sampled:** 3/23/2005 8:58 AM	
Location:	MW-05-09			**Completed:** 04/29/2005	

Notes:

a- Laboratory control spike not within control limits = 84%.
n Matrix Spike recovery not within control limits, recovery 118%.

Analyte	Analysis Date	Result	Units	RL	Method
Mercury, Methyl	4/15/2005	0.043	ng/L	0.02	1631E
Molybdenum, GF	3/31/2005	a 12.4	ug/L	5	246.2
Nickel	4/5/2005	9.6	ug/L	5	200.7
Nitrogen, Ammonia	3/30/2005	<0.1	mg/L	0.1	350.1
Nitrogen, Nitrate + Nitrite	4/4/2005	<0.1	mg/L	0.1	353.2
Palladium	4/5/2005	<25	ug/L	25	200.7
pH	3/25/2005	7.5	SU	0.1	150.1
Phosphorous, Total	3/30/2005	0.47	mg/L	0.1	365.4
Platinum	4/5/2005	<25	ug/L	25	200.7
Potassium	4/5/2005	n 2.1	mg/L	1	200.7
Selenium, GF	3/30/2005	<2	ug/L	2	270.2
Silver	4/3/2005	<1	ug/L	1	272.2
Sodium	4/5/2005	9.5	mg/L	0.5	200.7
Strontium	4/5/2005	37.7	ug/L	4	200.7
Sulfate	4/6/2005	13.8	mg/L	1	375.4
Thallium	3/31/2005	<2	ug/L	2	279.2
Titanium	4/1/2005	620	ug/L	100	283.2
TOC	4/4/2005	4.6	mg/L	1	415.1
Zinc	4/5/2005	11.8	ug/L	10	200.7

Approved By: _____
Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Sample ID:	S05082154C	**Project #:**	6845	**Sampler:** Client	**Type:** Grab
Client:	Barr Engineering			**Status:** Normal	**Matrix:** Liquid
Study:	Consultant			**NTS COC No:** 47825	
Descript:	PolyMet			**Sampled:** 3/23/2005	
Location:	Trip Blank			**Completed:** 04/29/2005	

Notes:

Analyte	Analysis Date	Result	Units	RL	Method
Mercury, Methyl	4/15/2005	<0.025	ng/L	0.02	1631E

Approved By: _____

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID:	S05082154D	**Project #:**	6845	**Sampler:** Client	**Type:** Grab - Filtered
Client:	Barr Engineering			**Status:** Normal	**Matrix:** Liquid
Study:	Consultant			**NTS COC No:** 47825	
Descript:	PolyMet			**Sampled:** 3/23/2005 12:00 PM	
Location:	MW-05-02			**Completed:** 03/31/2005	

Notes:

Analyte	Analysis Date	Result	Units	RL	Method
Aluminum	3/29/2005	44.6	ug/L	25	200.7
Cadmium	3/30/2005	<0.2	ug/L	0.2	213.2
Chromium	3/29/2005	<1	ug/L	1	218.2
Copper	3/29/2005	8	ug/L	2	220.2
Molybdenum, GF	3/29/2005	13.1	ug/L	5	246.2
Nickel	3/29/2005	<2	ug/L	2	249.2
Selenium, GF	3/29/2005	<2	ug/L	2	270.2
Silver	3/25/2005	<1	ug/L	1	272.2
Zinc	3/29/2005	<10	ug/L	10	200.7

Approved By:

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID: S050821550	**Project #:** 6845	**Sampler:** Client	**Type:** Grab - Filtered
Client: Barr Engineering		**Status:** Normal	**Matrix:** Liquid
Study: Consultant		**NTS COC No:** 47825	
Descript: PolyMet		**Sampled:** 3/23/2005 10:45 AM	
Location: MW-05-08		**Completed:** 03/31/2005	

Notes:

Analyte	Analysis Date	Result	Units	RL	Method
Aluminum	3/29/2005	214	ug/L	25	200.7
Cadmium	3/30/2005	<0.2	ug/L	0.2	213.2
Chromium	3/29/2005	<1	ug/L	1	218.2
Copper	3/29/2005	6.4	ug/L	2	220.2
Molybdenum, GF	3/29/2005	34.4	ug/L	5	246.2
Nickel	3/29/2005	<2	ug/L	2	249.2
Selenium, GF	3/29/2005	<2	ug/L	2	270.2
Silver	3/25/2005	<1	ug/L	1	272.2
Zinc	3/29/2005	<10	ug/L	10	200.7

Approved By: _____

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID:	S050821551	**Project #:**	6845	**Sampler:** Client	**Type:** Grab - Filtered
Client:	Barr Engineering			**Status:** Normal	**Matrix:** Liquid
Study:	Consultant			**NTS COC No:** 47825	
Descript:	PolyMet			**Sampled:** 3/23/2005 8:58 AM	
Location:	MW-05-09			**Completed:** 03/31/2005	

Notes:

Analyte	Analysis Date	Result	Units	RL	Method
Aluminum	3/29/2005	910	ug/L	25	200.7
Cadmium	3/30/2005	<0.2	ug/L	0.2	213.2
Chromium	3/29/2005	2.5	ug/L	1	218.2
Copper	3/29/2005	18.2	ug/L	2	220.2
Molybdenum, GF	3/29/2005	<5	ug/L	5	246.2
Nickel	3/29/2005	<2	ug/L	2	249.2
Selenium, GF	3/29/2005	<2	ug/L	2	270.2
Silver	3/25/2005	<1	ug/L	1	272.2
Zinc	3/29/2005	<10	ug/L	10	200.7

Approved By:

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID:	S05082155A	**Project #:**	6845	**Sampler:** Client	**Type:** Grab - Filtered
Client:	Barr Engineering			**Status:** Normal	**Matrix:** Liquid
Study:	Consultant			**NTS COC No:** 47825	
Descript:	PolyMet			**Sampled:** 3/23/2005	
Location:	Duplicate			**Completed:** 03/31/2005	

Notes:

Analyte	Analysis Date	Result	Units	RL	Method
Aluminum	3/29/2005	132	ug/L	25	200.7
Cadmium	3/30/2005	<0.2	ug/L	0.2	213.2
Chromium	3/29/2005	<1	ug/L	1	218.2
Copper	3/29/2005	2.3	ug/L	2	220.2
Molybdenum, GF	3/29/2005	32.9	ug/L	5	246.2
Nickel	3/29/2005	<2	ug/L	2	249.2
Selenium, GF	3/29/2005	<2	ug/L	2	270.2
Silver	3/25/2005	<1	ug/L	1	272.2
Zinc	3/29/2005	<10	ug/L	10	200.7

Approved By:

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

"Solutions for Technical Concerns"

MDH Laboratory # 027-137-157

Sample ID:	S05082155B	**Project #:**	6845	**Sampler:** Client	**Type:** Grab - Filtered
Client:	Barr Engineering			**Status:** Normal	**Matrix:** Liquid
Study:	Consultant			**NTS COC No:** 47825	
Descript:	PolyMet			**Sampled:** 3/23/2005 12:30 PM	
Location:	Supply Well			**Completed:** 03/31/2005	

Notes:

Analyte	Analysis Date	Result	Units	RL	Method
Aluminum	3/29/2005	<25	ug/L	25	200.7
Cadmium	3/30/2005	<0.2	ug/L	0.2	213.2
Chromium	3/29/2005	<1	ug/L	1	218.2
Copper	3/29/2005	<2	ug/L	2	220.2
Molybdenum, GF	3/29/2005	<5	ug/L	5	246.2
Nickel	3/29/2005	<2	ug/L	2	249.2
Selenium, GF	3/29/2005	<2	ug/L	2	270.2
Silver	3/25/2005	<1	ug/L	1	272.2
Zinc	3/29/2005	<10	ug/L	10	200.7

Approved By: _____

Project Manager:

Analyses were performed by methods approved by the U.S. Environmental Protection Agency and the Minnesota Department of Health.

Northeast Technical Services, Inc. makes no warranty except that the analysis has been made upon the samples received in accordance with generally accepted testing laboratory principles and practices. The results of the analysis may not be characteristic of the whole from which the sample was taken. This warranty is in lieu of all other warranties either expressed or implied.

NTS# 10845 COC# 47825

Chain of Custody

BARR
4700 West 77th Street
Minneapolis, MN 55435-4803
(952) 832-2600

Project Number: 23/69-862004 005

No 17756

Sample Identification	Collection Date	Collection Time	Matrix: Water	Matrix: Soil	Matrix: Other	Type: Grab	Type: Comp.	Type: QC	Volatile Organic (Unpres.)	Volatile Organic (Pres.)	Semivolatile Organic	Total Metals (HNO_3)	Dissolved Metals (HNO_3)	General (Unpreserved)	Cyanide (NaOH, ~~Asc. Acid~~)	Nutrients (H_2SO_4)	Oil and Grease (H_2SO_4)	TOC (H_2SO_4)	Sulfide (Zn Acetate)	Dioxin	WhirlPak	Total Phenol (H_2SO_4)	Methane	(HCL)/DRO, 1L Glass	Lugols, Glass, Amber	Formalin, Glass	Total No. Of Containers	Remarks/ Analysis Required:
1. MW-05-02	3/23/05	12:00	X			X						2		3	1							2					8	See attached list
2. MW-05-08		10:45	X			X						2		3	1							2					8	
3. MW-05-08 Dup		10:45	X			X						2		3	1							2					8	
4. MW-05-09		8:58	X			X						2		3	1							2					8	
5. Trip Blank			X			X								1													1	Methyl Hg
6. Supply well		12:30	X			X						2		3	1							2					8	See attached
7.																												
8. S050821534																												
9. 154B																												
10. 154A																												
11. 154B																												
12. 154C																												
13. 154C																												
14. 154D 1550																												
15. 155A 1551																												
16. 155B																												

Number of Containers/Preservative

Project Manager: Nels Nelson
Project Contact: Tina Print
Laboratory: NTS
Remarks/ Analysis Required:

Sampled By: Jeré Mohr
Remarks:

Relinquished By:
Relinquished By: Jeré Mohr — Date: 3-23-05 — Time: 13:40
Samples Shipped VIA: ☐ Air Freight ☐ Fed. Exp. ☐ Sampler ☐ Other

Received by:
Received by: M Koski — Date: 3-23-05 — Time: 13:39
Air Bill Number:

Distribution: White-Original Accompanies Shipment to Lab; Yellow - Field Copy; Pink - Lab Coordinator

8.7°C
Ice

Rev. 08/01/01

H:\RLGISTDFORMS\CHAINCST.CDR

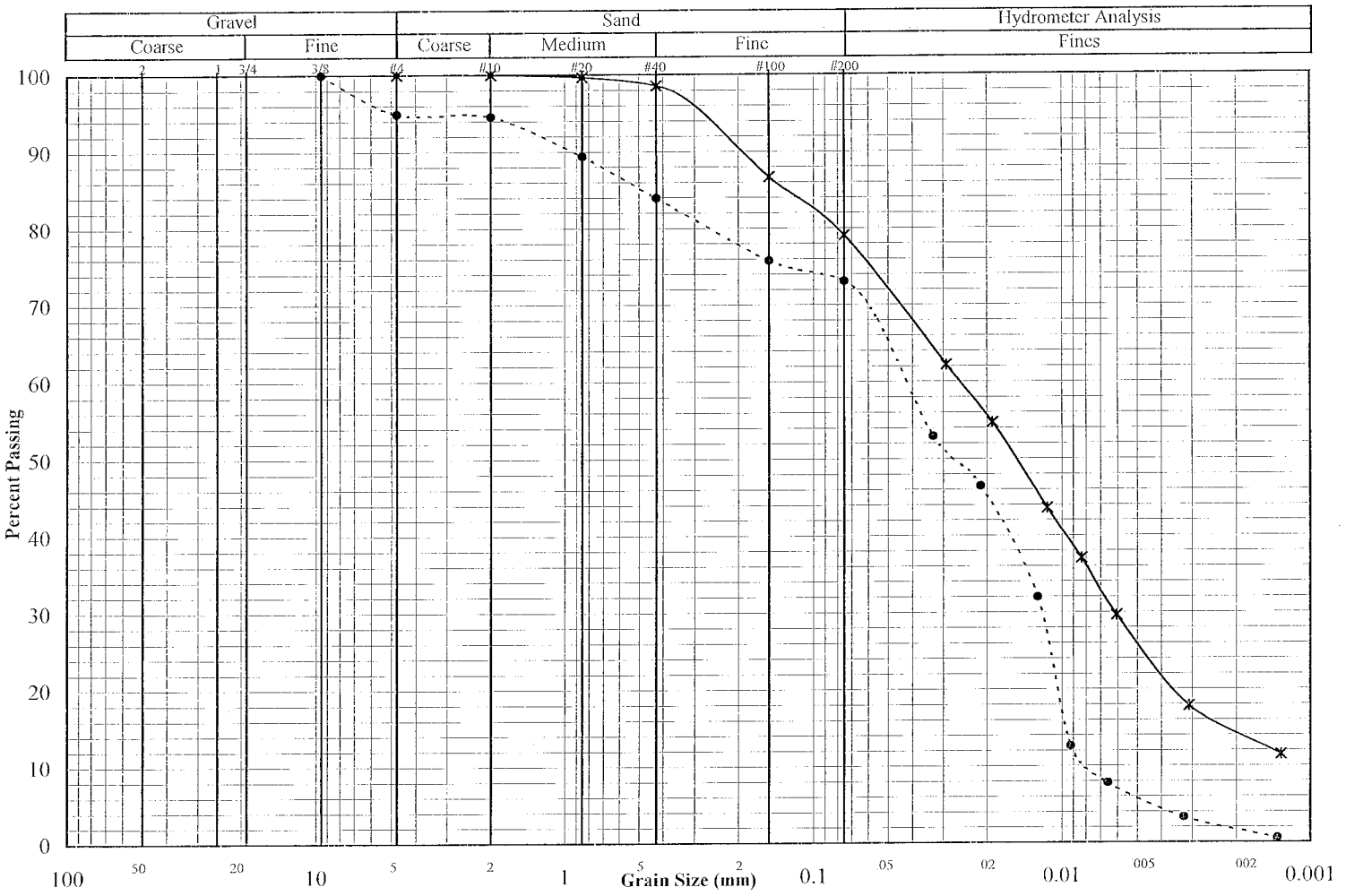
Appendix E

Grain Size Distribution ASTM D422

Job No.: **5333**

Project:	Polynet #23/69-862	Test Date:	5/15/05
Reported To:	Barr Engineering Company	Report Date:	5/24/05

	Location / Boring No	Sample No	Depth (ft)	Sample Type	Soil Classification
*	SB-05-01		4-5	Bags	Organic Clay, Organic Clay w/sand, some lenses & laminations of Silty Sand, Lean Clay & Fat Clay (OH)
●	SB-05-01		6-8	Bags	Peat w/pieces of wood (PT/OH)
◇					



Other Tests

	*	●	◇
Liquid Limit	66.5	406.9	
Plastic Limit	32.8	273.0	
Plasticity Index	33.7	133.9	
Water Content	49.1	407.7	
Dry Density (pcf)	69.4	13.5	
Specific Gravity	2.48	1.73	
Porosity			
Organic Content			
pH			
Shrinkage Limit	24.7		
Penetrometer			
Qu (psf)			

(* = assumed)

Percent Passing

	*	●	◇
Mass (g)	1028.0	580.0	
2"			
1.5"			
1"			
3/4"			
3/8"		100.0	
#4	100.0	94.9	
#10	100.0	94.6	
#20	99.7	89.4	
#40	98.5	83.9	
#100	86.7	75.8	
#200	79.0	73.1	

	*	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

* SB-05-01 @6-8: Pieces of wood retained on all sieves.

9301 Bryant Ave. South, Suite 107

SOIL ENGINEERING TESTING, INC.

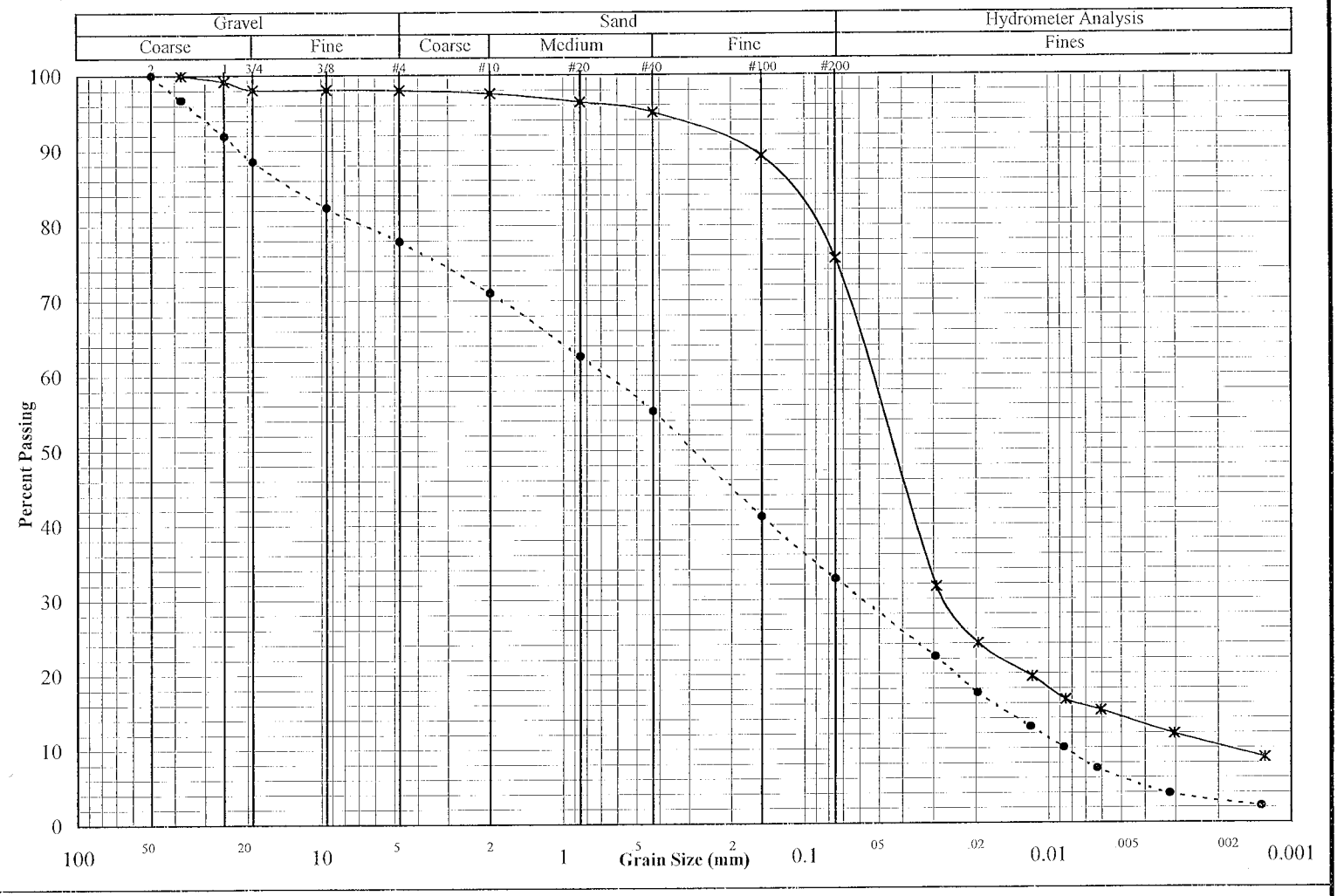
Bloomington, Minnesota 55420-3436

Grain Size Distribution ASTM D422

Job No. : **5333**

Project:	Polynet #23/69-862
Reported To:	Barr Engineering Company
Test Date:	5/15/05
Report Date:	5/24/05

	Location / Boring No	Sample No	Depth (ft)	Sample Type	Soil Classification
*	SB-05-04		2-7.5	Bags	Silty Clay w/sand and an occasional piece of gravel, brown & some gray (CL-ML)
●	SB-05-04		8.5-15.5	Bags	Silty sand w/a little gravel, gray (SM)
◇					



Other Tests

	*	●	◇
Liquid Limit	25.6	11.1	
Plastic Limit	20.0	10.0	
Plasticity Index	5.6	1.1	
Water Content	22.0	6.0	
Dry Density (pcf)	107.8		
Specific Gravity	2.78	2.76	
Porosity			
Organic Content			
pH			
Shrinkage Limit	17.8	12.4	
Penetrometer			
Qu (psf)			

(* = assumed)

Percent Passing

	*	●	◇
Mass (g)	5178.0	4568.0	
2"		100.0	
1.5"	100.0	96.8	
1"	99.2	91.9	
3/4"	98.1	88.6	
3/8"	98.1	82.4	
#4	98.0	77.9	
#10	97.5	71.0	
#20	96.4	62.6	
#40	95.0	55.2	
#100	89.2	41.1	
#200	75.5	32.7	

	*	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

9301 Bryant Ave. South, Suite 107

SOIL ENGINEERING TESTING, INC.

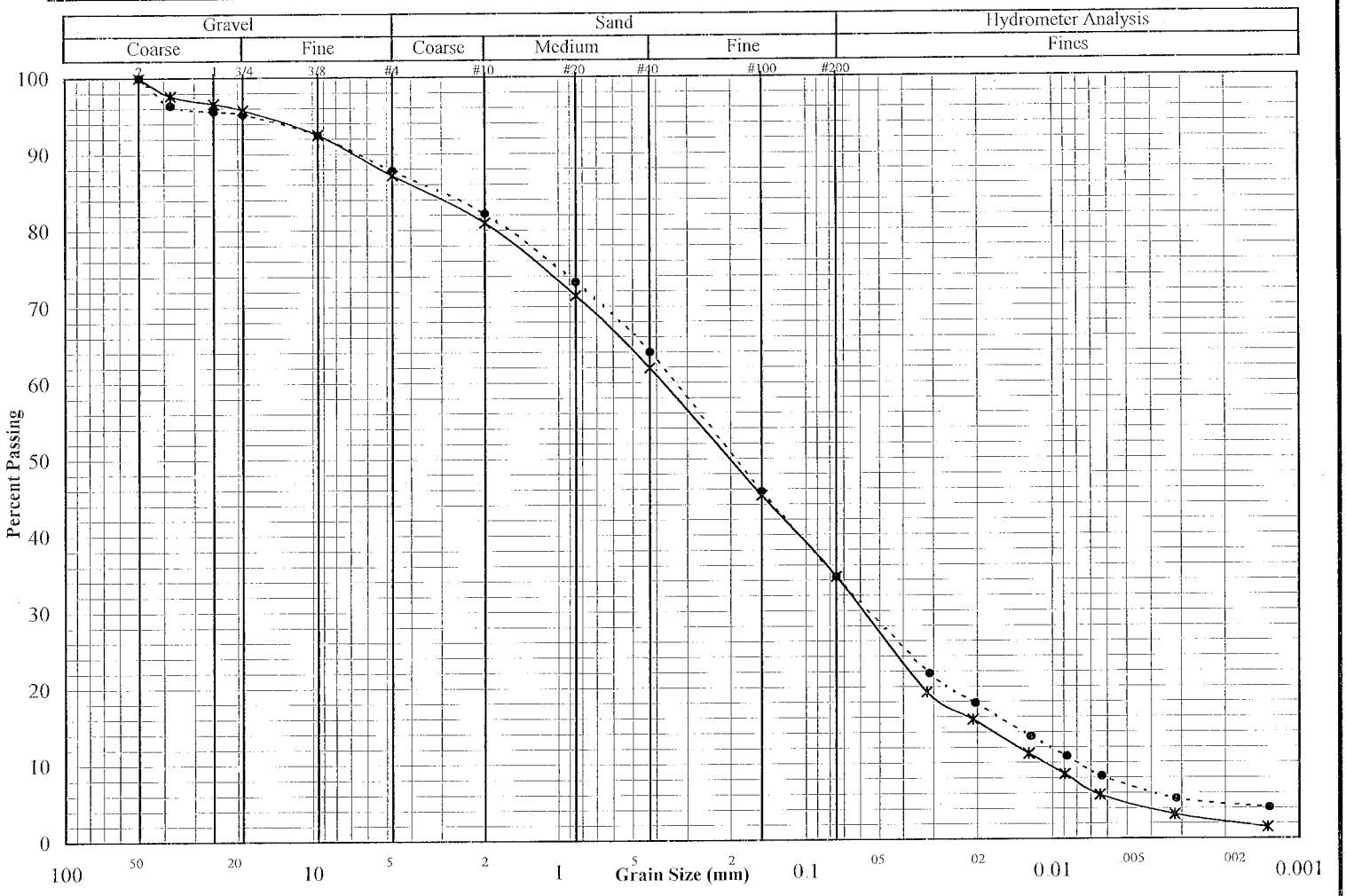
Bloomington, Minnesota 55420-3436

Grain Size Distribution ASTM D422

Job No. : **5333**

Project:	Polynet #23/69-862
Reported To.	Barr Engineering Company
Test Date:	5/15/05
Report Date:	5/24/05

	Location / Boring No	Sample No.	Depth (ft)	Sample Type	Soil Classification
*	SB-05-09		8.5-12.5	Bags	Silty Sand w/gravel, brown (SM)
●	SB-05-10		1-4	Bags	Silty Sand w/a few layers of (CL-ML) and a little gravel (SM/SC-SM)
◇					



Other Tests

	*	●	◇
Liquid Limit	NP	15.0	
Plastic Limit	NP	12.2	
Plasticity Index	NP	2.8	
Water Content	7.9	11.6	
Dry Density (pcf)			
Specific Gravity	2.76	2.76	
Porosity			
Organic Content			
pH			
Shrinkage Limit	13.6	15.2	
Penetrometer			
Qu (psf)			

(* = assumed)

Percent Passing

	*	●	◇
Mass (g)	5949.0	7162.0	
2"	100.0	100.0	
1.5"	97.6	96.4	
1"	96.6	95.6	
3/4"	95.7	95.2	
3/8"	92.5	92.4	
#4	87.2	87.8	
#10	80.9	82.1	
#20	71.4	73.2	
#40	61.9	64.0	
#100	45.1	45.7	
#200	34.5	34.4	

	*	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

9301 Bryant Ave. South, Suite 107

SOIL ENGINEERING TESTING, INC.

Bloomington, Minnesota 55420-3436

Moisture Density Curve ASTM: D698, Method B

Project: Polynet #23/69-862 Date: 5/25/05

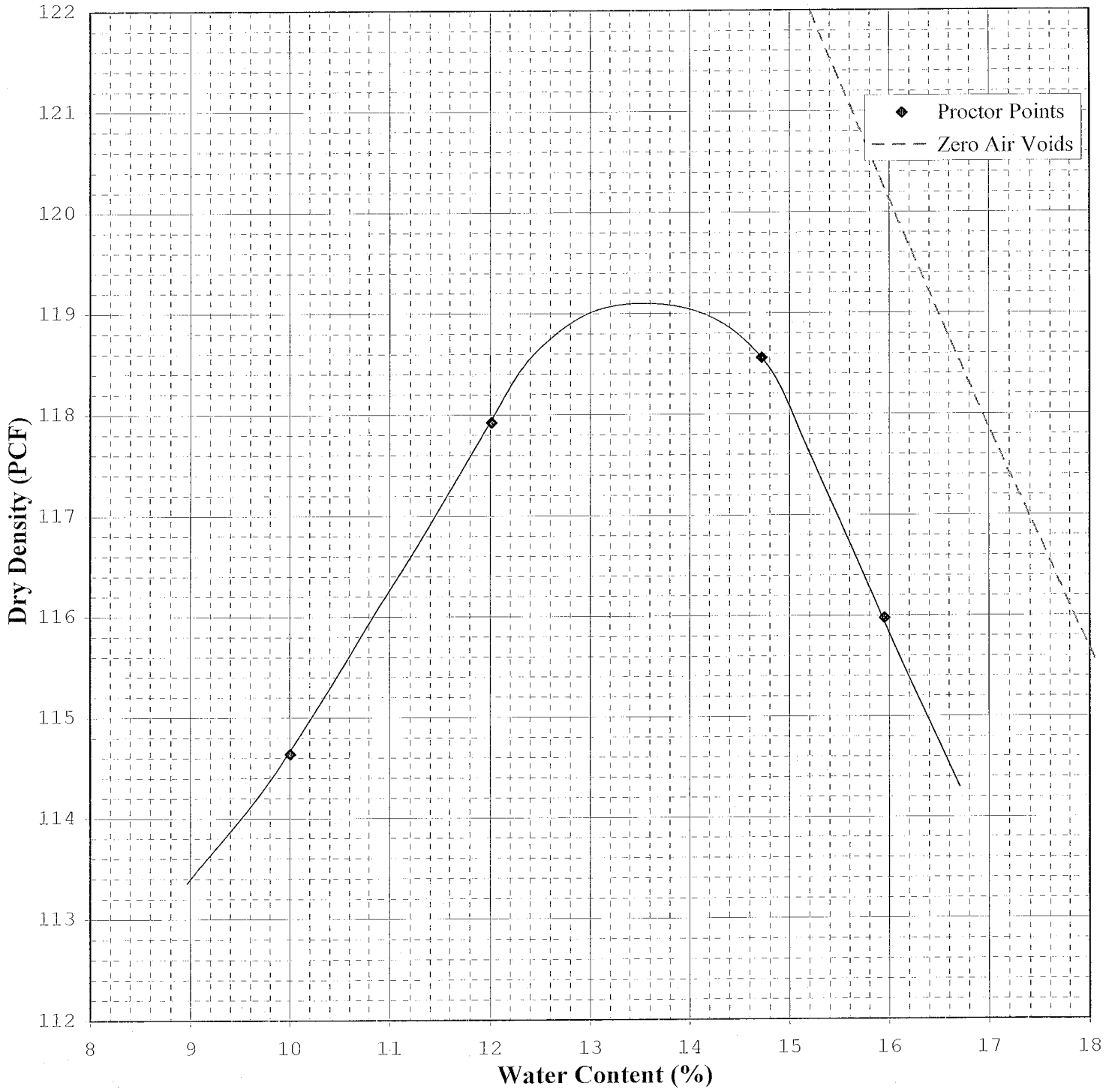
Client: Barr Engineering Company Job No. 5333

Boring No. SB-05-04 Sample: Depth(ft): 2.0-7.5 Location:

Soil Type: Silty Clay w/sand & an occasional piece of gravel, brown & some gray (CL-ML)

	W.C. (%)	LL	PL	PI	Specific Gravity
As Received	22.0	25.6	20.0	5.6	2.78

	Maximum Dry Density (pcf)	Opt. Water Content (%)
◆	119.1	13.5
△		



9301 Bryant Ave. South, Suite 107

SOIL ENGINEERING TESTING, INC.

Bloomington, Minnesota 55420-3436

Moisture Density Curve ASTM: D698, Method B

Project: Polynet #23/69-862 Date: 5/25/05

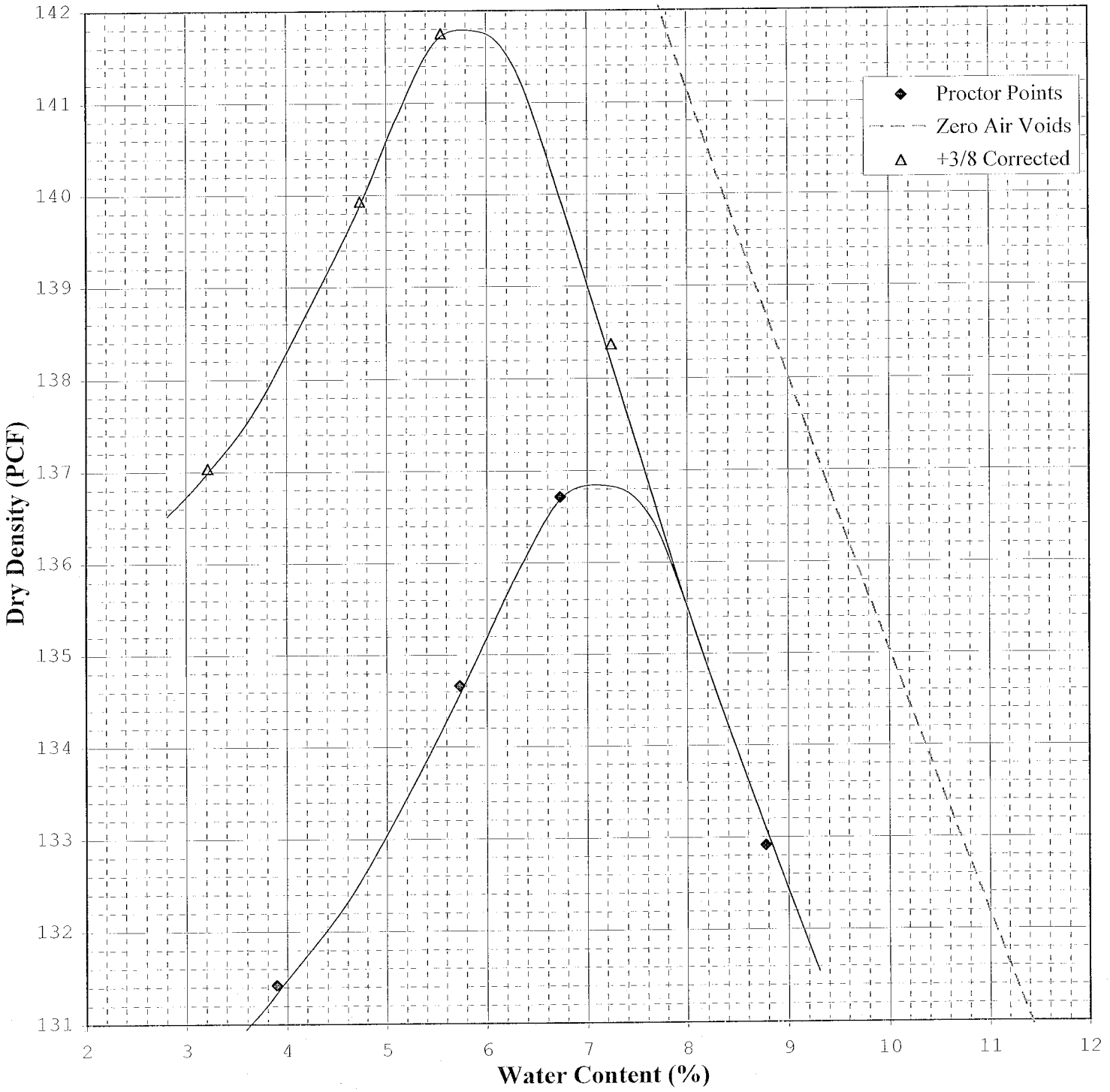
Client: Barr Engineering Company Job No. 5333

Boring No. SB-05-04 Sample: Depth(ft): 8.5-15.5 Location:

Soil Type: Silty Sand w/a little gravel, gray (SM)

As Received W.C. (%): 6.0 LL: 11.1 PL: 10.0 PI: 1.1 Specific Gravity: 2.76

	◆	△	◆	△
Maximum Dry Density (pcf):	136.8	141.7	Opt. Water Content (%):	7.1	5.8



9301 Bryant Ave. South, Suite 107 SOIL ENGINEERING TESTING, INC. Bloomington, Minnesota 55420-3436

Moisture Density Curve ASTM: D698, Method B

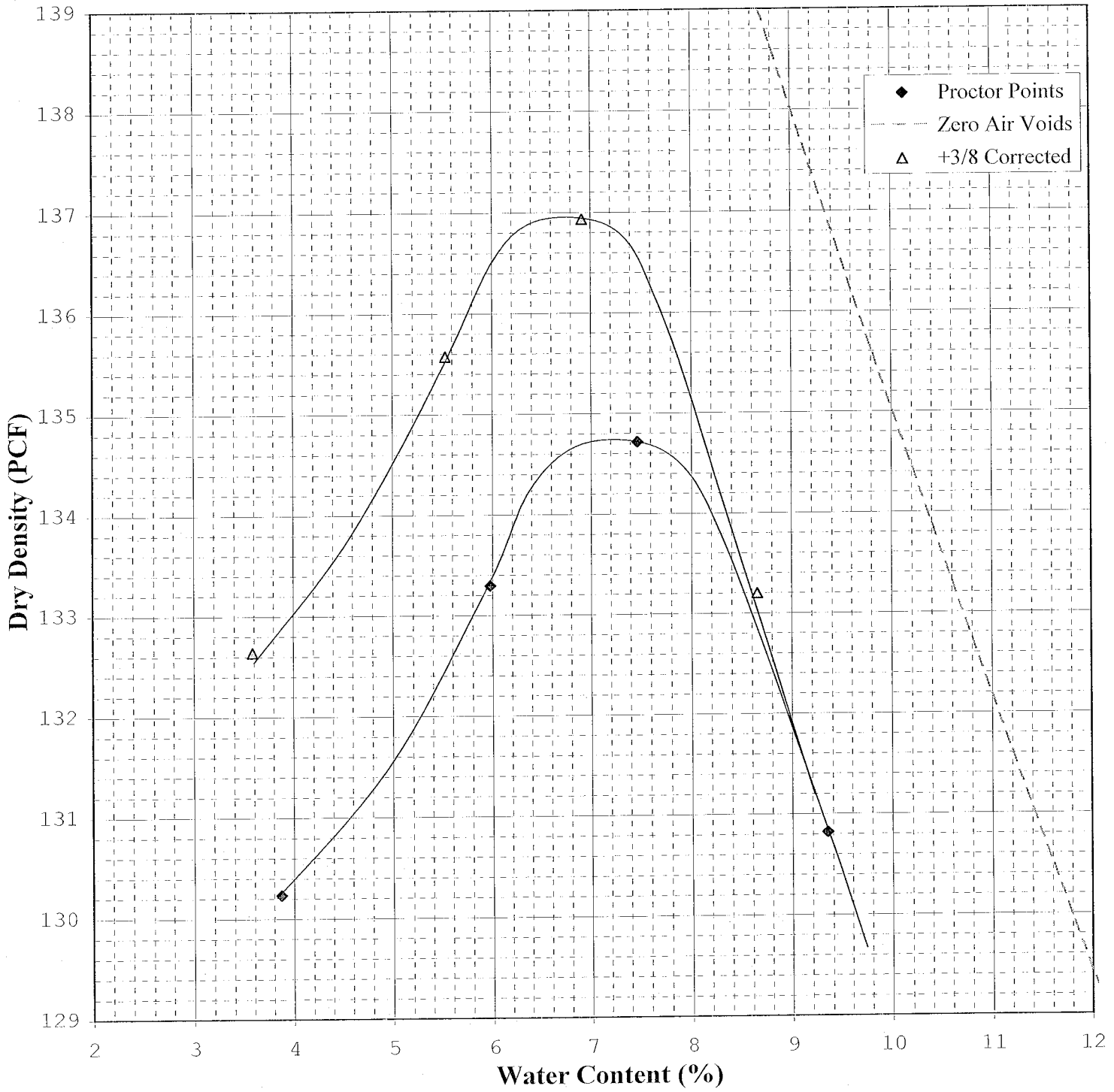
Project: Polynet #23/69-862
Client: Barr Engineering Company
Date: 5/25/05
Job No. 5333

Boring No. SB-05-09 Sample: Depth(ft): 8.5-12.5 Location:

Soil Type: Silty Sand w/gravel, brown (SM)

As Received W.C. (%): 7.9 LL: NP PL: NP PI: NP Specific Gravity: 2.76

	◆	△		◆	△
Maximum Dry Density (pcf):	134.7	137.0	Opt. Water Content (%):	7.2	6.7



9301 Bryant Ave. South, Suite 107

SOIL ENGINEERING TESTING, INC.

Bloomington, Minnesota 55420-3436

Moisture Density Curve ASTM: D698, Method B

Project: Polynet #23/69-862 Date: 5/25/05

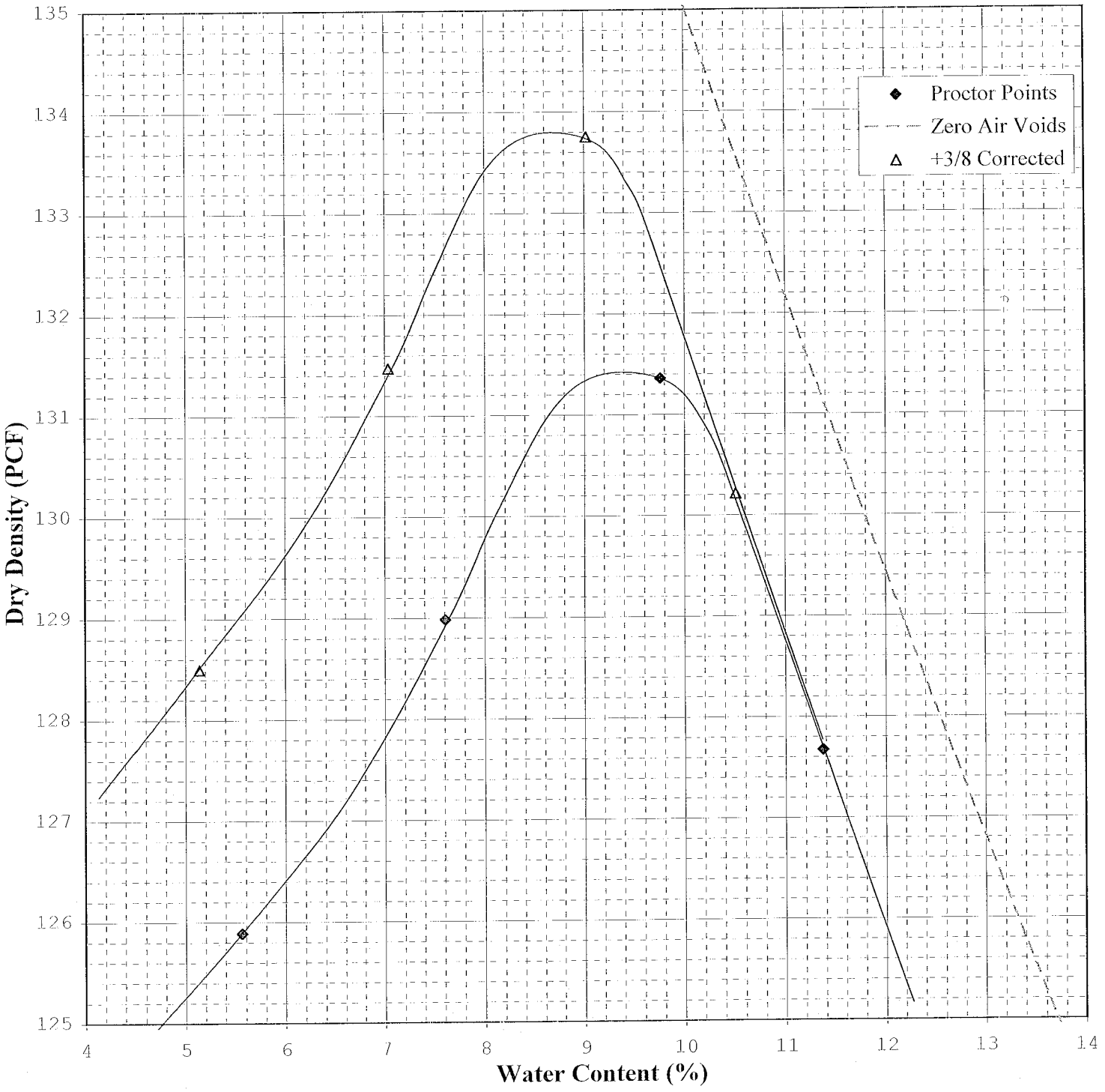
Client: Barr Engineering Company Job No. 5333

Boring No. SB-05-10 Sample: Depth(ft): 1-4 Location:

Soil Type: Silty Sand w/a few layers of Silty Clay and a little gravel (SM/SC-SM)

As Received W.C. (%): 11.6 LL: 15.0 PL: 12.2 PI: 2.8 Specific Gravity: 2.76

	◆	△	◆	△
Maximum Dry Density (pcf):	131.4	133.8	Opt. Water Content (%):	9.4	8.6



9301 Bryant Ave. South, Suite 107 SOIL ENGINEERING TESTING, INC. Bloomington, Minnesota 55420-3436

Permeability Test Data

Project: Polynet - #23/69-862 Date: 6/8/2005

Reported To: Barr Engineering Company Job No.: 5333-A

Boring No.:	SB-05-04	SB-05-04	SB-05-09	SB-05-10			
Depth (ft):	2.0-7.5	8.5-15.5	8.5-12.5	1.0-4.0			
Sample Type:	Bags	Bags	Bags	Bags			
Soil Type:	Silty Clay w/Sand & an occasional piece of gravel, brown & some gray (CL-ML)	Silty Sand w/a Little Gravel, Gray (SM)	Silty Sand w/Gravel, Brown (SM)	Silty Sand w/a Little Gravel (SM/SC-SM)			
Atterberg Limits							
LL	25.6	11.1	NP	15.0			
PL	20.0	10.0	NP	12.2			
PI	5.6	1.1	NP	2.8			
Moisture Density Standard Proctor							
Opt. Water Content	13.5	7.1	7.2	9.4			
Max Dry Den. (pcf)	119.1	136.8	134.7	131.4			
Permeability Test							
Before Test Conditions: Test Wall	Flexible	Flexible	Flexible	Flexible			
Porosity:	0.325	0.228	0.237	0.251			
Ht. (in):	3.00	3.00	3.00	3.00			
Dia. (in):	2.85	2.85	2.85	2.85			
Dry Density (pcf):	112.9	129.2	127.7	125.3			
Water Content:	16.1%	9.6%	9.6%	12.0%			
Test Type:	Falling	Falling	Falling	Falling			
Max Head (ft):	3.9	3.9	3.9	3.9			
Confining press. (Effective-psi):	2.0	2.0	2.0	2.0			
Trial No.:	10-14	8-12	12-16	10-14			
Water Temp °C:	23.0	23.0	23.0	23.0			
% Compaction	94.8%	94.5%	94.8%	95.4%			
% Saturation (After Test)	95.6%						
Coefficient of Permeability							
K @ 20 °C (cm/sec)	**8.7×10^{-8}**	**6.0×10^{-7}**	**1.5×10^{-6}**	**1.5×10^{-7}**			
K @ 20 °C (ft/min)	**1.7×10^{-7}**	**5.6×10^{-6}**	**2.9×10^{-6}**	**3.0×10^{-7}**			
Notes:							

9301 Bryant Ave South Suite 107 SOIL ENGINEERING TESTING, INC. Bloomington, Minnesota 55420-3436

University of Minnesota
Soil Testing Laboratory

SOIL TEST REPORT

Lawn and Garden

Client Copy

Department of Soil, Water, and Climate
Minnesota Extension Service
Agricultural Experiment Station

SB -05-01 4'to5'

SOIL ENGINEERING TESTING, INC.
ATTN: JOHN WHELAN
SUITE 107
9301 BRYANT AVE S
BLOOMINGTON MN 55420-3436

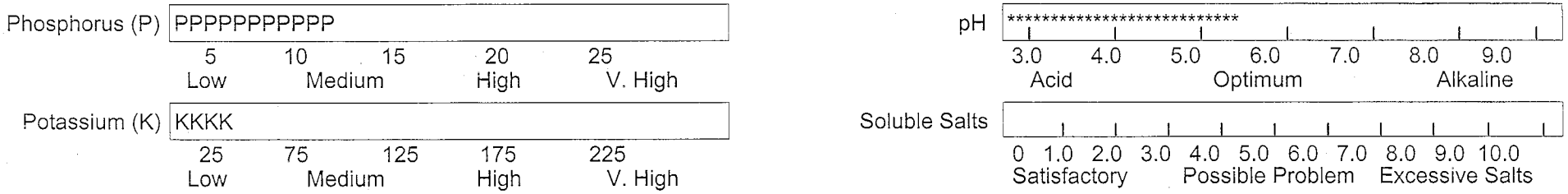
Page	1
Report No.	29239
Laboratory No.	60688
Date Received	05/17/2005
Date Reported	05/19/2005

Sample/Field Number: 4T05

SOIL TEST RESULTS

Estimated Soil Texture	Organic Matter %	Soluble Salts mmhos/cm	pH	Buffer Index	Nitrate NO3-N ppm	Olsen Phosphorus ppm P	Bray 1 Phosphorus ppm P	Potassium ppm K	Sulfur SO4 -S ppm	Zinc ppm	Iron ppm	Manganese ppm	Copper ppm	Boron ppm	Calcium ppm	Magnesium ppm	Lead ppm
Medium	9.8		5.6	6.1			10	30									

INTERPRETATION OF SOIL TEST RESULTS



RECOMMENDATIONS FOR: Before seeding or sodding

LIME RECOMMENDATION: 0 LBS/1,000 SQ.FT.

Grass not watered Clippings not removed

TOTAL AMOUNT OF EACH NUTRIENT TO APPLY PER YEAR:*

NITROGEN	PHOSPHATE	POTASH
1 LBS/1,000 SQ.FT.	5 LBS/1,000 SQ.FT.	6 LBS/1,000 SQ.FT.
44 LBS/ACRE	220 LBS/ACRE	260 LBS/ACRE

THE APPROXIMATE RATIO OR PROPORTION OF THESE NUTRIENTS IS: 5-25-30

During preparation of the seedbed and prior to seeding, till into the top 4-6 inches of soil a fertilizer that supplies the recommended amount of phosphate and potash (ie. a fertilizer that contains little or no nitrogen). Much of the nitrogen applied to this depth will be lost through leaching.

Next, rake into the surface prior to seeding an amount of fertilizer that contains only nitrogen such as 34-0-0 or 46-0-0, or a grade that is high in nitrogen but low in phosphate and potash, that will result in 0.5 lb. of nitrogen per 1000 sq. ft. (22 lb./acre) being applied.

An additional 0.5 lb. N/1000 sq. ft. (22 lb./ acre) should be applied two weeks after seedling emergence or sodding and watered in. After this, the rates and timing of N fertilization are based on the cultural practices that are used. Contact your county extension educator for more information. Water frequently the first year. Retest soil after one year to determine maintenance recommendations. It is recommended that clippings not be removed.

*CAUTION! Do not apply more that 1 lb. nitrogen per 1000 sq. ft. in one application to avoid burning the grass. Additional information is provided on the back side of

County: HENNEPIN. For additional information, contact the YARD & GARDEN LINE: Phone: 612-624-4771 Website: www.extension.umn.edu/yardandgarden

Explanation of Soil Test Report

Soil pH: This is a measurement of acidity, which is important because it affects:
1) the availability of several plant nutrients, 2) the activity of soil microorganisms,
3) the ability of soil to hold plant nutrients.
The optimum pH for most plants and soil microorganisms is between 6.0 and 7.0. Some plants, however, such as blueberries, azaleas and others prefer more acidic conditions (i.e., lower pH). Since grasses are quite tolerant to a wide pH range, lime is generally not recommended on established grasses.

Buffer Index: This test is used only to determine the lime requirements and should not be confused with soil pH.

Organic Matter: The Regular Series test includes an estimate of the percent organic matter. The classifications used for organic matter are: Low 0-3%, Medium 3.1-4.5%, High 4.6-19%, and Organic Soil 19.1% or greater.
Organic Matter has many important functions in soils, some of which are:
1) to improve soil structure, water infiltration, drainage, and soil aeration on clayey type soils.
2) to act as a reservoir of available plant nutrients
3) to increase the water holding capacity of sandy soils. When organic matter is low, large amounts of peat, compost, crop residues, manure or other organic amendments are required to change the organic matter content of the soil.

Soluble Salts: This test is used primarily to check for high amounts of salts in "black" dirt that is used in new landscaping or for top-dressing purposes and for possible salt damage to grass from salted streets and sidewalks. Excess salt must be leached by intense watering before the plants will grow normally.

Lead: Recommended for soils or sandbox sand to which young children may be repeatedly exposed.

Other Special Tests: Recommendations are not provided for these tests since the interpretations are limited to special situations. The tests are provided for professionals only.

Interpretation of Soil Tests: The relative levels of various nutrients are indicated by a series of symbols. A line of P or K letters ending in the lower areas of the block, represents a low level of the nutrient.

Recommendations and Calculation of Fertilizer Required: Lime and plant nutrient recommendations are given in pounds per area (1000 square feet for turf, or 100 square feet for gardens, trees or shrubs). Plant nutrients are expressed as nitrogen (N), phosphate (P205) and potash (K20). The recommended plant nutrient requirements can be met by applying a given amount of fertilizer(s).

Commercial fertilizers are identified with a 3-numeral code that indicates the percentage of nitrogen, phosphate, and potash. A common garden fertilizer labeled 10-10-10 contains 10% of each of the three plant nutrients. Most garden centers sell fertilizer blends (10-10-10) rather than single nutrient fertilizers like 20-0-0 or 0-0-60 which are available from fertilizer dealers. Because there are a limited number of fertilizer blends on the market you may not find one that exactly meets the ratio recommended (reported on the front side). In this case, you should select a fertilizer blend with the closest ratio of N-P2O5-K2O to that recommended.

Since meeting the exact amount required for each nutrient will not be possible in all cases, it's most important to match the Nitrogen (N) required. The amount of fertilizer to apply that will give the recommended amount of nitrogen can be obtained from the following table:

Table to Determine Total Amount of Fertilizer to Apply Based on Actual Nitrogen Recommended:

	Nitrogen Recommended			
Fertilizer Nitrogen % (First number of fertilizer grade on bag)	0.1 lb. N/100 sq. ft	0.15 lb. N/100 sq ft	0.2 lb. N/100 sq. ft	1.0 lb. N/1000 sq. ft
	Total lbs. fertilizer to apply / 100 sq. ft			Total lbs. fertilizer to apply/1000 sq. ft
45	0.22	0.33	0.44	2.2
37	0.27	0.40	0.54	2.7
36	0.28	0.42	0.56	2.8
33	0.30	0.45	0.60	3.0
32	0.31	0.46	0.62	3.1
30	0.33	0.50	0.66	3.3
28	0.36	0.54	0.72	3.6
27	0.37	0.56	0.74	3.7
25	0.40	0.60	0.80	4.0
24	0.42	0.63	0.84	4.2
22	0.45	0.68	0.90	4.5
21	0.48	0.72	0.96	4.8
20	0.50	0.75	1.00	5.0
19	0.53	0.80	1.06	5.3
18	0.56	0.84	1.12	5.6
16	0.63	0.95	1.26	6.3
15	0.67	1.00	1.34	6.7
13	0.77	1.15	1.54	7.7
12	0.83	1.25	1.66	8.3
10	1.00	1.50	2.00	10.0
8	1.25	1.88	2.50	12.5
6	1.67	2.50	3.34	16.7
5	2.00	3.00	4.00	20.0

Example: If the N (nitrogen) recommendation is for 0.1 lb. N/100 ft. sq. and the fertilizer grade you selected has a ratio of 18-6-12 (column 1), you will have to apply 0.56 lbs of this fertilizer (from column 2) for each 0.1 lb. N recommended per 100 square feet.

Note: 2 cups (1 pint) of dry fertilizer weighs about 1 pound.

General Information

For Home Lawns: follow these rules when applying fertilizer:
1) use a formula designed for lawns (not trees, flower beds or farms).
2) apply fertilizer during the spring and late summer (do not fertilize frozen ground).
3) apply fertilizer uniformly in two directions with a mechanical spreader.
4) sweep up any fertilizer accidentally applied on sidewalks and driveways to prevent its movement to storm sewers, lakes and streams.
5) water the lawn thoroughly after fertilizing to dissolve the nutrients and force them down to the soil surface to combine with the soil.

For Vegetable and Flower Gardens:
Manure, compost, or other forms of organic matter may be added. These amendments provide a good source of trace nutrients as well as improve soil granulation. Three to five bushels of manure or compost per 100 square feet are recommended.

University of Minnesota
Soil Testing Laboratory

SOIL TEST REPORT

Lawn and Garden

Client Copy

Department of Soil, Water, and Climate
Minnesota Extension Service
Agricultural Experiment Station

SB-05-01 6' to 8'

SOIL ENGINEERING TESTING, INC.
ATTN: JOHN WHELAN
SUITE 107
9301 BRYANT AVE S
BLOOMINGTON MN 55420-3436

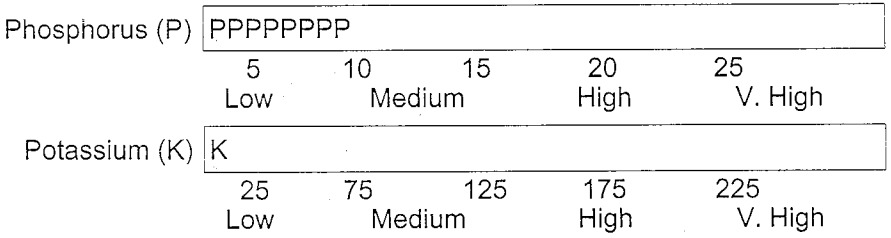
Page	**2**
Report No.	**29239**
Laboratory No.	**60689**
Date Received	**05/17/2005**
Date Reported	**05/19/2005**

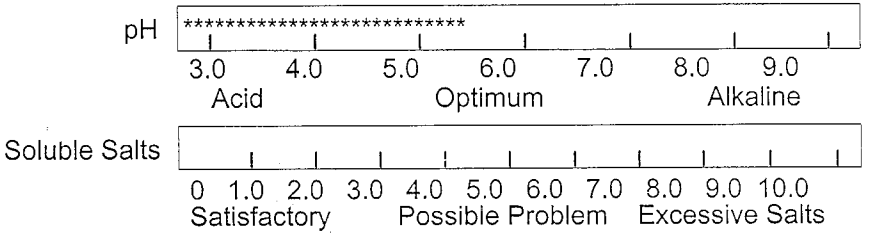
Sample/Field Number: 6T08

SOIL TEST RESULTS

Estimated Soil Texture	Organic Matter %	Soluble Salts mmhos/cm	pH	Buffer Index	Nitrate NO3-N ppm	Olsen Phosphorus ppm P	Bray 1 Phosphorus ppm P	Potassium ppm K	Sulfur SO4 -S ppm	Zinc ppm	Iron ppm	Manganese ppm	Copper ppm	Boron ppm	Calcium ppm	Magnesium ppm	Lead ppm
Peat	**68.7**		**5.6**				**7**	**9**									

INTERPRETATION OF SOIL TEST RESULTS





RECOMMENDATIONS FOR: Before seeding or sodding

LIME RECOMMENDATION: 0 LBS/1,000 SQ.FT.

Grass not watered Clippings not removed

TOTAL AMOUNT OF EACH NUTRIENT TO APPLY PER YEAR:*

NITROGEN	PHOSPHATE	POTASH
1 LBS/1,000 SQ.FT.	5 LBS/1,000 SQ.FT.	6 LBS/1,000 SQ.FT.
44 LBS/ACRE	220 LBS/ACRE	260 LBS/ACRE

THE APPROXIMATE RATIO OR PROPORTION OF THESE NUTRIENTS IS: 5-25-30

During preparation of the seedbed and prior to seeding, till into the top 4-6 inches of soil a fertilizer that supplies the recommended amount of phosphate and potash (ie. a fertilizer that contains little or no nitrogen). Much of the nitrogen applied to this depth will be lost through leaching.

Next, rake into the surface prior to seeding an amount of fertilizer that contains only nitrogen such as 34-0-0 or 46-0-0, or a grade that is high in nitrogen but low in phosphate and potash, that will result in 0.5 lb. of nitrogen per 1000 sq. ft. (22 lb./acre) being applied.

An additional 0.5 lb. N/1000 sq. ft. (22 lb./ acre) should be applied two weeks after seedling emergence or sodding and watered in. After this, the rates and timing of N fertilization are based on the cultural practices that are used. Contact your county extension educator for more information. Water frequently the first year. Retest soil after one year to determine maintenance recommendations. It is recommended that clippings not be removed.

*CAUTION! Do not apply more that 1 lb. nitrogen per 1000 sq. ft. in one application to avoid burning the grass. Additional information is provided on the back side of

County: HENNEPIN. For additional information, contact the YARD & GARDEN LINE: Phone: 612-624-4771 Website: www.extension.umn.edu/yardandgarden

Explanation of Soil Test Report

Soil pH: This is a measurement of acidity, which is important because it affects:
1) the availability of several plant nutrients, 2) the activity of soil microorganisms,
3) the ability of soil to hold plant nutrients.
The optimum pH for most plants and soil microorganisms is between 6.0 and 7.0. Some plants, however, such as blueberries, azaleas and others prefer more acidic conditions (i.e., lower pH). Since grasses are quite tolerant to a wide pH range, lime is generally not recommended on established grasses.

Buffer Index: This test is used only to determine the lime requirements and should not be confused with soil pH.

Organic Matter: The Regular Series test includes an estimate of the percent organic matter. The classifications used for organic matter are: Low 0-3%, Medium 3.1-4.5%, High 4.6-19%, and Organic Soil 19.1% or greater.
Organic Matter has many important functions in soils, some of which are:
1) to improve soil structure, water infiltration, drainage, and soil aeration on clayey type soils.
2) to act as a reservoir of available plant nutrients
3) to increase the water holding capacity of sandy soils. When organic matter is low, large amounts of peat, compost, crop residues, manure or other organic amendments are required to change the organic matter content of the soil.

Soluble Salts: This test is used primarily to check for high amounts of salts in "black" dirt that is used in new landscaping or for top-dressing purposes and for possible salt damage to grass from salted streets and sidewalks. Excess salt must be leached by intense watering before the plants will grow normally.

Lead: Recommended for soils or sandbox sand to which young children may be repeatedly exposed.

Other Special Tests: Recommendations are not provided for these tests since the interpretations are limited to special situations. The tests are provided for professionals only.

Interpretation of Soil Tests: The relative levels of various nutrients are indicated by a series of symbols. A line of P or K letters ending in the lower areas of the block, represents a low level of the nutrient.

Recommendations and Calculation of Fertilizer Required: Lime and plant nutrient recommendations are given in pounds per area (1000 square feet for turf, or 100 square feet for gardens, trees or shrubs). Plant nutrients are expressed as nitrogen (N), phosphate (P205) and potash (K20). The recommended plant nutrient requirements can be met by applying a given amount of fertilizer(s).

Commercial fertilizers are identified with a 3-numeral code that indicates the percentage of nitrogen, phosphate, and potash. A common garden fertilizer labeled 10-10-10 contains 10% of each of the three plant nutrients. Most garden centers sell fertilizer blends (10-10-10) rather than single nutrient fertilizers like 20-0-0 or 0-0-60 which are available from fertilizer dealers. Because there are a limited number of fertilizer blends on the market you may not find one that exactly meets the ratio recommended (reported on the front side). In this case, you should select a fertilizer blend with the closest ratio of N-P2O5-K2O to that recommended.

Since meeting the exact amount required for each nutrient will not be possible in all cases, it's most important to match the Nitrogen (N) required. The amount of fertilizer to apply that will give the recommended amount of nitrogen can be obtained from the following table:

Table to Determine Total Amount of Fertilizer to Apply Based on Actual Nitrogen Recommended:

	Nitrogen Recommended			
Fertilizer Nitrogen % (First number of fertilizer grade on bag)	0.1 lb. N/100 sq. ft	0.15 lb. N/100 sq ft	0.2 lb. N/100 sq. ft	1.0 lb. N/1000 sq. ft. Total lbs. fertilizer to apply/1000 sq. ft
	Total lbs. fertilizer to apply / 100 sq. ft			
45	0.22	0.33	0.44	2.2
37	0.27	0.40	0.54	2.7
36	0.28	0.42	0.56	2.8
33	0.30	0.45	0.60	3.0
32	0.31	0.46	0.62	3.1
30	0.33	0.50	0.66	3.3
28	0.36	0.54	0.72	3.6
27	0.37	0.56	0.74	3.7
25	0.40	0.60	0.80	4.0
24	0.42	0.63	0.84	4.2
22	0.45	0.68	0.90	4.5
21	0.48	0.72	0.96	4.8
20	0.50	0.75	1.00	5.0
19	0.53	0.80	1.06	5.3
18	0.56	0.84	1.12	5.6
16	0.63	0.95	1.26	6.3
15	0.67	1.00	1.34	6.7
13	0.77	1.15	1.54	7.7
12	0.83	1.25	1.66	8.3
10	1.00	1.50	2.00	10.0
8	1.25	1.88	2.50	12.5
6	1.67	2.50	3.34	16.7
5	2.00	3.00	4.00	20.0

Example: If the N (nitrogen) recommendation is for 0.1 lb. N/100 ft. sq. and the fertilizer grade you selected has a ratio of 18-6-12 (column 1), you will have to apply 0.56 lbs of this fertilizer (from column 2) for each 0.1 lb. N recommended per 100 square feet.

Note: 2 cups (1 pint) of dry fertilizer weighs about 1 pound.

General Information

For Home Lawns: follow these rules when applying fertilizer:
1) use a formula designed for lawns (not trees, flower beds or farms).
2) apply fertilizer during the spring and late summer (do not fertilize frozen ground).
3) apply fertilizer uniformly in two directions with a mechanical spreader.
4) sweep up any fertilizer accidentally applied on sidewalks and driveways to prevent its movement to storm sewers, lakes and streams.
5) water the lawn thoroughly after fertilizing to dissolve the nutrients and force them down to the soil surface to combine with the soil.

For Vegetable and Flower Gardens:
Manure, compost, or other forms of organic matter may be added. These amendments provide a good source of trace nutrients as well as improve soil granulation. Three to five bushels of manure or compost per 100 square feet are recommended.